

In the Claims:

Kindly amend the claims as follows:

1. (Currently Amended) A treatment of waste process for the use of mediated electrochemical oxidation (MEO) for the oxidation, conversion/recovery, and decontamination ~~(such as cleaning equipment and containers, etc.)~~ of all previously defined inorganic solid, liquid, or gas where higher oxidation states exist selected from a group consisting of which includes, but is not limited to, halogenated inorganic compounds (except fluorinated), inorganic pesticides and herbicides, inorganic fertilizers, carbon residues, incinerator residue, inorganic carbon compounds, mineral formations, mining tailings, inorganic salts, metals and metal compounds, and combinations thereof etc.; and combined waste (~~e.g.~~ a mixture of any of the foregoing with each other or other non-inorganic materials) further comprising disposing an electrolyte in an electrochemical cell, separating the electrolyte into an anolyte portion and a catholyte portion with an ion-selective membrane, ~~or~~ semi permeable, microporous polymer, ceramic or glass frit membrane; ; applying a direct current voltage between the anolyte portion and the catholyte portion, placing the waste and/or inorganic materials in the anolyte portion, and oxidizing the waste and/or inorganic materials in the anolyte portion with a mediated electrochemical oxidation (MEO) process, wherein the anolyte portion further comprises a mediator or mediators (oxidizing species) in aqueous solution and containing an acid, neutral or alkaline electrolytes, and wherein the mediator oxidizing species are simple anion redox couples described in Table I as below; Type I isopolyanions complex anion redox couples formed by incorporation of Mo, W, V, Nb, Ta, or mixtures thereof as addenda atoms; Type I heteropolyanions complex anion redox couples formed by incorporation in to Type I isopolyanions as heteroatoms any of the elements listed in Table II either singly or in

combination thereof, or heteropolyanions complex anion redox couples containing at least one heteroatom type element contained in both Table I and Table II below or combinations of the mediator oxidizing species from any or all of these generic groups:

Table I: Simple Anion Redox Couples

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
I	A	None			
	B	Copper (Cu)	+2	Cu ⁺² (cupric) H ₂ CuO ₂ (bicuprite) Cu ₂ O ₂ ⁺² (cuprite)	+2 Species/ +3, +4 Species; +3 Species/ +4 Species
			+3	Cu ⁺³ CuO ₂ ⁻ (cuprate) Cu ₂ O ₃ (sesquioxide)	
			+4	CuO ₂ (peroxide)	
		Silver (Ag)	+1	Ag ⁺ (argentous) AgO ⁻ (argentite)	+1 Species/ +2, +3 Species; +2 Species/ +3 Species
			+2	Ag ⁺² (argentic) AgO (argentic oxide)	
			+3	AgO ⁺ (argetyl) Ag ₂ O ₃ (sesquioxide)	
		Gold (Au)	+1	Au ⁺ (aurous)	+1 Species/ +3, +4 Species; + 3 Species/ +4 Species
			+3	Au ⁺³ (auric) AuO ⁻ (auryl) H ₃ AuO ₃ ⁻ (auric acid) H ₂ AuO ₃ ⁻ (monoaurate) HAuO ₃ ⁻² (diaurate) AuO ₃ ⁻³ (triaurate) Au ₂ O ₃ (auric oxide) Au(OH) ₃ (auric hydroxide)	
			+4	AuO ₂ (peroxide)	
II	A	Magnesium (Mg)	+2	Mg ⁺² (magnesian)	+2 Species/ +4 Species
			+4	MgO ₂ (peroxide)	
		Calcium (Ca)	+2	Ca ⁺²	+2 Species/ +4 Species
			+4	CaO ₂ (peroxide)	
		Strontium	+2	Sr ⁺²	+2 Species/ +4 Species
			+4	SrO ₂ (peroxide)	
		Barium (Ba)	+2	Ba ⁺²	+2 Species/ +4 Species
			+4	BaO ₂ (peroxide)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
II	B	Zinc (Zn)	+2	Zn^{+2} (zincic)	+2 Species/ +4 Species
				ZnOH^+ (zincyl) HZnO_2^- (bizincate) ZnO_2^{-2} (zincate)	
			+4	ZnO_2 (peroxide)	
		Mercury (Hg)	+2	Hg^{+2} (mercuric)	+2 Species/ +4 Species
				$\text{Hg}(\text{OH})_2$ (mercuric hydroxide) HHgO_2^- (mercurate)	
			+4	HgO_2 (peroxide)	
III	A	Boron	+3	H_3BO_3 (orthoboric acid)	+3 Species/ +4.5, +5 Species
				H_2BO_3^- , HBO_3^{-2} , BO_3^{-3} (orthoborates) BO_2^- (metaborate) $\text{H}_2\text{B}_4\text{O}_7$ (tetraboric acid) $\text{HB}_4\text{O}_7^-/\text{B}_4\text{O}_7^{-2}$ (tetraborates) $\text{B}_2\text{O}_4^{-2}$ (diborate) $\text{B}_6\text{O}_{10}^{-2}$ (hexaborate)	
			+4.5	B_2O_5^- (diborate)	
			+5	$\text{BO}_3^-/\text{BO}_2 \cdot \text{H}_2\text{O}$ (perborate)	
		Thallium (Tl)	+1	Tl^{+1} (thallous)	+1 Species/ +3 or +3.33 Species;
			+3	Tl^{+3} (thallic)	+3 Species/ +3.33 Species
				TlO^+ , TlOH^{+2} , $\text{Tl}(\text{OH})_2^+$ (thallyl) Tl_2O_3 (sesquioxide) $\text{Tl}(\text{OH})_3$ (hydroxide)	
			+3.33	Tl_3O_5 (peroxide)	
	B	See Rare Earths and Actinides			

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
IV	A	Carbon (C)	+4	<u>H₂CO₃ (carbonic acid)</u> <u>HCO₃⁻ (bicarbonate)</u> <u>CO₃⁻² (carbonate)</u>	<u>+4 Species/</u> <u>+5, +6 Species</u>
			+5	<u>H₂C₂O₆ (perdicarbonic acid)</u>	
			+6	<u>H₂CO₄ (permonocarbonic acid)</u>	
		Germanium (Ge)	+4	<u>H₂GeO₃ (germanic acid)</u> <u>HGeO₃⁻ (bigermaniate)</u> <u>GeO₃⁻⁴ (germinate)</u> <u>Ge⁺⁴ (germanic)</u> <u>GeO₄⁻⁴</u> <u>H₂Ge₂O₅ (digermanic acid)</u> <u>H₂Ge₄O₉ (tetragermanic acid)</u> <u>H₂Ge₅O₁₁ (pentagermanic acid)</u> <u>HGe₅O₁₁⁻ (bipentagermanate)</u>	<u>+4 Species/</u> <u>+6 Species</u>
			+6	<u>Ge₅O₁₁⁻² (pentagermanate)</u>	
		Tin (Sn)	+4	<u>Sn⁺⁴ (stannic)</u> <u>HSnO₃⁻ (bistannate)</u> <u>SnO₃⁻² (stannate)</u> <u>SnO₂ (stannic oxide)</u> <u>Sn(OH)₄ (stannic hydroxide)</u>	<u>+4 Species/</u> <u>+7 Species</u>
			+7	<u>SnO₄⁻ (perstannate)</u>	
		Lead (Pb)	+2	<u>Pb⁺² (plumbous)</u> <u>HPbO₂⁻ (biplumbite)</u> <u>PbOH⁺</u> <u>PbO₂⁻² (plumbite)</u> <u>PbO (plumbus oxide)</u>	<u>+2, +2.67, +3</u> <u>Species/+4</u> <u>Species</u>
			+2.67	<u>Pb₃O₄ (plumbo-plumbic oxide)</u>	
			+3	<u>Pb₂O₃ (sequioxide)</u>	
		Lead (Pb)	+4	<u>Pb⁺⁴ (plumbic)</u> <u>PbO₃⁻² (metaplumbate)</u> <u>HPbO₃⁻ (acid metaplumbate)</u> <u>PbO₄⁻⁴ (orthoplumbate)</u> <u>PbO₂ (dioxide)</u>	<u>+2, +2.67, +3</u> <u>Species/+4</u> <u>Species</u>
IV	A	Lead (Pb)	+4		

<u>GROUP</u>	<u>SUB GROUP</u>	<u>ELEMENT</u>	<u>VALENCE</u>	<u>SPECIES</u>	<u>SPECIFIC REDOX COUPLES</u>
<u>IV</u>	<u>B</u>	<u>Titanium</u>	<u>+4</u>	<u>TiO⁺² (pertitanyl)</u> <u>HTiO₄⁻ (titanate)</u> <u>TiO₂ (dioxide)</u>	<u>+4 Species/</u> <u>+6 Species</u>
			<u>+6</u>	<u>TiO₂⁺² (pertitanyl)</u> <u>HTiO₄⁻ (acid pertitanate)</u> <u>TiO₄⁻² (pertitanate)</u> <u>TiO₃ (peroxide)</u>	
		<u>Zirconium (Zr)</u>	<u>+4</u>	<u>Zr⁺⁴ (zirconic)</u> <u>ZrO⁺² (zirconyl)</u> <u>HZrO₃⁻ (zirconate)</u>	<u>+4 Species/ +5,</u> <u>+6, +7 Species</u>
			<u>+5</u>	<u>Zr₂O₅ (pentoxide)</u>	
			<u>+6</u>	<u>ZrO₃ (peroxide)</u>	
			<u>+7</u>	<u>Zr₂O₇ (heptoxide)</u>	
		<u>Hafnium (Hf)</u>	<u>+4</u>	<u>Hf⁺⁴ (hafnic)</u> <u>HfO⁺² (hafnyl)</u>	<u>+4 Species/</u> <u>+6 Species</u>
			<u>+6</u>	<u>HfO₃ (peroxide)</u>	
<u>V</u>	<u>A</u>	<u>Nitrogen</u>	<u>+5</u>	<u>HNO₃ (nitric acid)</u> <u>NO₃⁻ (nitrate)</u>	<u>+5 species/</u> <u>+7 Species</u>
			<u>+7</u>	<u>HNO₄ (pernitric acid)</u>	
		<u>Phosphorus (P)</u>	<u>+5</u>	<u>H₃PO₄ (orthophosphoric acid)</u> <u>H₂PO₄⁻ (monoorthophosphate)</u> <u>HPO₄⁻² (diorthophosphate)</u> <u>PO₄⁻³ (triorthophosphate)</u> <u>HPO₃ (metaphosphoric acid)</u> <u>H₄P₂O₇ (pyrophosphoric acid)</u> <u>H₃P₃O₁₀ (triphosphoric acid)</u> <u>H₆P₄O₁₃ (tetraphosphoric acid)</u>	<u>+5 Species/</u> <u>+6, +7 species</u>
<u>V</u>	<u>A</u>	<u>Phosphorus (P)</u>	<u>+6</u>	<u>H₄P₂O₈ (perphosphoric acid)</u>	<u>+5 Species/</u> <u>+6, +7 Species</u>
			<u>+7</u>	<u>H₃PO₅ (monoperphosphoric acid)</u>	

<u>GROUP</u>	<u>SUB GROUP</u>	<u>ELEMENT</u>	<u>VALENCE</u>	<u>SPECIES</u>	<u>SPECIFIC REDOX COUPLES</u>
<u>V</u>	<u>A</u>	<u>Arsenic (As)</u>	<u>+5</u>	<u>H₃AsO₄ (ortho-arsenic acid)</u> <u>H₂AsO₄⁻ (mono ortho-arsenate)</u> <u>HAsO₄⁻² (di-ortho-arsenate)</u> <u>AsO₄⁻³ (tri-ortho-arsenate)</u> <u>AsO₂⁺ (arsenyl)</u>	<u>+5 Species/</u> <u>+7 species</u>
			<u>+7</u>	<u>AsO₃⁺ (perarsenyl)</u>	
		<u>Bismuth (Bi)</u>	<u>+3</u>	<u>Bi⁺³ (bismuthous)</u> <u>BiOH⁺² (hydroxybismuthous)</u> <u>BiO⁺ (bismuthyl)</u> <u>BiO₂⁻ (metabismuthite)</u>	<u>+3 Species/</u> <u>+3.5, +4, +5</u> <u>Species</u>
			<u>+3.5</u>	<u>Bi₄O₇ (oxide)</u>	
			<u>+4</u>	<u>Bi₂O₄ (tetroxide)</u>	
			<u>+5</u>	<u>BiO₃⁻ (metabismuthite)</u> <u>Bi₂O₅ (pentoxide)</u>	
	<u>B</u>	<u>Vanadium (V)</u>	<u>+5</u>	<u>VO₂⁺ (vanadic)</u> <u>H₃V₂O₇⁻ (pyrovanadate)</u> <u>H₂VO₄⁻ (orthovanadate)</u> <u>VO₃⁻ (metavanadate)</u> <u>HVO₄⁻² (orthovanadate)</u> <u>VO₄⁻³ (orthovanadate)</u> <u>V₂O₅ (pentoxide)</u> <u>H₄V₂O₇ (pyrovanadic acid)</u> <u>HVO₃ (metavanadic acid)</u> <u>H₄V₆O₁₇ (hexavanadic acid)</u>	<u>+5 Species/</u> <u>+7, +9 Species</u>
			<u>+7</u>	<u>VO₄⁻ (pervanadate)</u>	
			<u>+9</u>	<u>VO₅⁻ (hypervanadate)</u>	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES		
V	B	Niobium (Nb)	+5	<u>NbO₃⁻ (metaniobate)</u> <u>NbO₄⁻³ (orthoniobate)</u> <u>Nb₂O₅ (pentoxide)</u> <u>HNbO₃ (niobid acid)</u>	<u>+5 Species/ +7 species</u>		
			+7	<u>NbO₄⁻ (perniobate)</u> <u>Nb₂O₇ (perniobic oxide)</u> <u>HNbO₄ (perniobic acid)</u>			
			Tantalum (Ta)	+5		<u>TaO₃⁻ (metatantalate)</u> <u>TaO₄⁻³ (orthotantalate)</u> <u>Ta₂O₅ (pentoxide)</u> <u>HTaO₃ (tantalic acid)</u>	<u>+5 species/ +7 species</u>
				+7		<u>TaO₄⁻ (pentantalate)</u> <u>Ta₂O₇ (pertantalate)</u> <u>HTaO₄•H₂O (pertantalic acid)</u>	
		VI	A	Sulfur (S)	+6	<u>H₂SO₄ (sulfuric acid)</u> <u>HSO₄⁻ (bisulfate)</u> <u>SO₄⁻² (sulfate)</u>	<u>+6 Species/ +7, +8 Species</u>
					+7	<u>S₂O₈⁻² (dipersulfate)</u>	
+8	<u>H₂SO₅ (momopersulfuric acid)</u>						
Selenium (Se)	+6			<u>H₂Se₂O₄ (selenic acid)</u> <u>HSeO₄⁻ (biselenate)</u> <u>SeO₄⁻² (selenate)</u>	<u>+6 species/ +7 Species</u>		
	+7	<u>H₂Se₂O₈ (perdiselenic acid)</u>					
		Tellurium (Te)	+6	<u>H₂TeO₄ (telluric acid)</u> <u>HTeO₄⁻ (bitellurate)</u> <u>TeO₄⁻² (tellurate)</u>	<u>+6 species/ +7 species</u>		
			+7	<u>H₂Te₂O₈ (perditellenic acid)</u>			
			Polonium (Po)	+2		<u>Po⁺² (polonous)</u>	<u>+2, +4 species/ +6 Species</u>
		+4		<u>PoO₃⁻² (polonate)</u>			
+6	<u>PoO₃ (peroxide)</u>						

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VI	B	Chromium	+3	Cr^{+3} (chromic) CrOH^{+2} , $\text{Cr}(\text{OH})_2^+$ (chromyls) CrO_2^- , CrO_3^{-3} (chromites) Cr_2O_3 (chromic oxide) $\text{Cr}(\text{OH})_3$ (chromic hydroxide)	+3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+4	CrO_2 (dioxide) $\text{Cr}(\text{OH})_4$ (hydroxide)	
			+6	H_2CrO_4 (chromic acid) HCrO_4^- (acid chromate) CrO_4^{-2} (chromate) $\text{Cr}_2\text{O}_7^{-2}$ (dichromate)	
		Molybdenum (Mo)	+6	HMoO_4^- (bimolybdate) MoO_4^{-2} (molybdate) MoO_3 (molybdic trioxide) H_2MoO_4 (molybolic acid)	+6 Species/ +7 Species
			+7	MoO_4^- (permolybdate)	
		Tungsten (W)	+6	WO_4^{-2} tungstic) WO_3 (trioxide) H_2WO_4 (tungstic acid)	+6 Species/ +8 Species
			+8	WO_5^{-2} (pertungstic) H_2WO_5 (pertungstic acid)	
VII	A	Chlorine (Cl)	+1	HClO (hypochlorous acid) ClO^- (hypochlorite)	+1 Species/ +3, +5, +7 Species; +3 Species/ +5, +7 Species;
			+3	HClO_2 (chlorous acid) ClO_2^- (chlorite)	+5 Species/ +7 Species
			+5	HClO_3 (chloric acid) ClO_3^- (chlorate)	
			+7	HClO_4 (perchloric acid) ClO_4^- , HClO_5^{-2} , ClO_5^{-3} , $\text{Cl}_2\text{O}_9^{-4}$ (perchlorates)	

<u>GROUP</u>	<u>SUB GROU P</u>	<u>ELEMENT</u>	<u>VALENCE</u>	<u>SPECIES</u>	<u>SPECIFIC REDOX COUPLES</u>
VII	A	<u>Bromine (Br)</u>	<u>+1</u>	<u>HBrO (hypobromous acid)</u> <u>BrO⁻ (hypobromite)</u>	<u>+1 Species/+3,</u> <u>+5, +7 Species;</u> <u>+3 Species/ +5,</u> <u>+7 Species;</u> <u>+5 Species/ +7</u> <u>Species</u>
			<u>+3</u>	<u>HBrO₂ (bromous acid)</u> <u>BrO₂⁻ (bromite)</u>	
			<u>+5</u>	<u>HBrO₃ (bromic acid)</u> <u>BrO₃⁻ (bromate)</u>	
			<u>+7</u>	<u>HBrO₄ (perbromic acid)</u> <u>BrO₄⁻, HBrO₅⁻², BrO₅⁻³, Br₂O₉⁻⁴</u> <u>(prebromates)</u>	
		<u>Iodine</u>	<u>+1</u>	<u>HIO (hypoiodous acid)</u> <u>IO⁻ (hypoiodite)</u>	<u>+1 Species/+3,</u> <u>+5, +7 Species;</u> <u>+3 Species/ +5,</u> <u>+7 Species;</u> <u>+5 Species/ +7</u> <u>Species</u>
			<u>+3</u>	<u>HIO₂ (iodous acid)</u> <u>IO₂⁻ (iodite)</u>	
			<u>+5</u>	<u>HIO₃ (iodic acid)</u> <u>IO₃⁻ (iodate)</u>	
			<u>+7</u>	<u>HIO₄ (periodic acid)</u> <u>IO₄⁻, HIO₅⁻², IO₅⁻³, I₂O₉⁻⁴</u> <u>(periodates)</u>	
	B	<u>Manganese (Mn)</u>	<u>+2</u>	<u>Mn⁺² (manganeous)</u> <u>HMnO₂⁻ (dimanganite)</u>	<u>+2 Species/ +3,</u> <u>+4, +6, +7</u> <u>Species;</u> <u>+3 Species/ +4,</u> <u>+6, +7 Species;</u> <u>+4 Species/ +6,</u> <u>+7 Species;</u> <u>+6 Species/ +7</u> <u>Species</u>
			<u>+3</u>	<u>Mn⁺³ (manganic)</u>	
			<u>+4</u>	<u>MnO₂ (dioxide)</u>	
			<u>+6</u>	<u>MnO₄⁻² (manganate)</u>	
			<u>+7</u>	<u>MnO₄⁻ (permanganate)</u>	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VIII	Period 4	Iron (Fe)	+3	Fe^{+3} (ferric) $\text{Fe}(\text{OH})^{+2}$ $\text{Fe}(\text{OH})_2^{+}$ FeO_2^{-2} (ferrite)	+3 Species/+4, +5, +6 Species;
			+4	FeO^{+2} (ferryl) FeO_2^{-2} (perferrite)	+4 Species/ +5, +6 Species; +5 Species/ +6 Species
			+5	FeO_2^{+} (perferryl)	
			+6	FeO_3^{-2} (ferrate)	
		Cobalt (Co)	+2	Co^{+2} (cobalous) HCoO_2^{-} (dicobaltite)	+2 Species/ +3, +4 Species; +3 Species/ +4 Species
			+3	Co^{+3} (cobaltic) Co_2O_3 (cobaltic oxide)	
			+4	CoO_2 (peroxide) H_2CoO_3 (cobaltic acid)	
		Nickel (Ni)	+2	Ni^{+2} (nickelous) NiOH^{+} HNiO_2^{-} (dinickelite) NiO_2^{-2} (nickelite)	+2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+3	Ni^{+3} (nickelic) Ni_2O_3 (nickelic oxide)	
			+4	NiO_2 (peroxide)	
			+6	NiO_4^{-2} (nickelate)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VIII	Period 5	<u>Ruthenium</u> (Ru)	+2	<u>Ru⁺²</u>	+2 Species/ +3, +4, +5, +6, +7, +8 Species;
			+3	<u>Ru⁺³</u> <u>Ru₂O₃ (sesquioxide)</u> <u>Ru(OH)₃ (hydroxide)</u>	+3 Species/ +4, +5, +6, +7, +8 Species; +4 Species/ +5, +6, +7, +8 Species; +5 Species/ +6, +7, +8 Species;
			+4	<u>Ru⁺⁴ (ruthenic)</u> <u>RuO₂ (ruthenic dioxide)</u> <u>Ru(OH)₄ (ruthenic hydroxide)</u>	+6 Species/ +7, +8 Species; +7 Species/ +8 Species
			+5	<u>Ru₂O₅ (pentoxide)</u>	
			+6	<u>RuO₄⁻² (ruthenate)</u> <u>RuO₂⁺² (ruthenyl)</u> <u>RuO₃ (trioxide)</u>	
			+7	<u>RuO₄⁻ (perruthenate)</u>	
			+8	<u>H₂RuO₄ (hyperuthenic acid)</u> <u>HRuO₅⁻ (diperruthenate)</u> <u>RuO₄ (ruthenium tetroxide)</u>	
		<u>Rhodium</u> (Rh)	+1	<u>Rh⁺ (hyporhodos)</u>	+1 Species/+2, +3, +4, +6 Species;
			+2	<u>Rh⁺² (rhodous)</u>	+2 Species/ +3, +4, +6 Species;
			+3	<u>Rh⁺³ (rhodic)</u> <u>Rh₂O₃ (sesquioxide)</u>	+3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+4	<u>RhO₂ (rhodic oxide)</u> <u>Rh(OH)₄ (hydroxide)</u>	
			+6	<u>RhO₄⁻² (rhodate)</u> <u>RhO₃ (trioxide)</u>	
		<u>Palladium</u>	+2	<u>Pd⁺² (palladous)</u> <u>PdO₂⁻² (palladite)</u>	+2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species;
			+3	<u>Pd₂O₃ (sesquioxide)</u>	+4 Species/ +6 Species
			+4	<u>Pd O₃⁻² (palladate)</u> <u>PdO₂ (dioxide)</u> <u>Pd(OH)₄ (hydroxide)</u>	
			+6	<u>PdO₃ (peroxide)</u>	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VIII	Period 6	Iridium (Ir)	+3	Ir^{+3} (iridic) Ir_2O_3 (iridium sesquioxide) $\text{Ir}(\text{OH})_3$ (iridium hydroxide)	+3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+4	IrO_2 (iridic oxide) $\text{Ir}(\text{OH})_4$ (iridic hydroxide)	
			+6	IrO_4^{-2} (iridate) IrO_3 (iridium peroxide)	
		Platinum (Pt)	+2	Pt^{+2} (platinous)	+2, +3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+3	Pt_2O_3 (sesquioxide)	
			+4	PtO_3^{-2} (palatinate) PtO^{+2} (platinyI) $\text{Pt}(\text{OH})^{+3}$ PtO_2 (platinic oxide)	
			+6	PtO_4^{-2} (Perplatinate) PtO_3 (perplatonic oxide)	
IIIB	Rare earths	Cerium (Ce)	+3	Ce^{+3} (cerous) Ce_2O_3 (cerous oxide) $\text{Ce}(\text{OH})_3$ (cerous hydroxide)	+3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+4	Ce^{+4} , $\text{Ce}(\text{OH})^{+3}$, $\text{Ce}(\text{OH})_2^{+2}$, $\text{Ce}(\text{OH})_3^{+}$ (ceric) CeO_2 (ceric oxide)	
			+6	CeO_3 (peroxide)	
		Praseodymium (Pr)	+3	Pr^{+3} (praseodymous) Pr_2O_3 (sesquioxide) $\text{Pr}(\text{OH})_3$ (hydroxide)	+3 species/ +4 species
			+4	Pr^{+4} (praseodymic) PrO_2 (dioxide)	
		Neodymium	+3	Nd^{+3} Nd_2O_3 (sesquioxide)	+3 Species/ +4 Species
			+4	NdO_2 (peroxide)	
		Terbium (Tb)	+3	Tb^{+3} Tb_2O_3 (sesquioxide)	+3 Species/ +4 Species
			+4	TbO_2 (peroxide)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
IIIB	Actinides	Thorium (Th)	+4	Th ⁺⁴ (thoric) ThO ⁺² (thoryl) HThO ₃ ⁻ (thorate)	+4 Species/ +6 Species
			+6	ThO ₃ (acid peroxide)	
		Uranium (U)	+6	UO ₂ ⁺² (uranyl) UO ₃ (uranic oxide)	+6 Species/ +8 Species
			+8	HUO ₅ ⁻ , UO ₅ ⁻² (peruranates) UO ₄ (peroxide)	
		Neptunium (Np)	+5	NpO ₂ ⁺ (hyponeptunyl) Np ₂ O ₅ (pentoxide)	+5 Species/ +6, +8 Species; +6 Species/ +8 Species
			+6	NpO ₂ ⁺² (neptunyl) NpO ₃ (trioxide)	
			+8	NpO ₄ (peroxide)	
		Plutonium (Pu)	+3	Pu ⁺³ (hypoplutinous)	+3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species
			+4	Pu ⁺⁴ (plutinous) PuO ₂ (dioxide)	
			+5	PuO ₂ ⁺ (hypoplutonyl) Pu ₂ O ₅ (pentoxide)	
			+6	PuO ₂ ⁺² (plutonyl) PuO ₃ (peroxide)	
		Americium (Am)	+3	Am ⁺³ (hypoamericious)	+3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species
			+4	Am ⁺⁴ (americous) AmO ₂ (dioxide) Am(OH) ₃ (hydroxide)	
			+5	AmO ₂ ⁺ (hypoamericyl) Am ₂ O ₅ (pentoxide)	
			+6	AmO ₂ ⁺² (americyl) AmO ₃ (peroxide)	

Table II: Elements Participating as Heteroatoms in Heteropolyanion Complex Anion Redox Couple Mediators

<u>GROUP</u>	<u>SUB GROUP</u>	<u>ELEMENT</u>
<u>I</u>	<u>A</u>	<u>Lithium (Li), Sodium (Na), Potassium (K), and Cesium (Cs)</u>
	<u>B</u>	<u>Copper (Cu), Silver (Ag), and Gold (Au)</u>
<u>II</u>	<u>A</u>	<u>Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), and Barium (Ba)</u>
	<u>B</u>	<u>Zinc (Zn), Cadmium (Cd), and Mercury (Hg)</u>
<u>III</u>	<u>A</u>	<u>Boron (B), and Aluminum (Al)</u>
	<u>B</u>	<u>Scandium (Sc), and Yttrium (Y) – (See Rare Earths)</u>
<u>IV</u>	<u>A</u>	<u>Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb)</u>
	<u>B</u>	<u>Titanium (Ti), Zirconium (Zr), and Hafnium (Hf)</u>
<u>V</u>	<u>A</u>	<u>Nitrogen (N), Phosphorous (P), Arsenic (As), Antimony (Sb), and Bismuth (Bi)</u>
	<u>B</u>	<u>Vanadium (V), Niobium (Nb), and Tantalum (Ta)</u>
<u>VI</u>	<u>A</u>	<u>Sulfur (S), Selenium (Se), and Tellurium (Te)</u>
	<u>B</u>	<u>Chromium (Cr), Molybdenum (Mo), and Tungsten (W)</u>
<u>VII</u>	<u>A</u>	<u>Fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I)</u>
	<u>B</u>	<u>Manganese (Mn), Technetium (Tc), and Rhenium (Re)</u>
<u>VIII</u>	<u>Period 4</u>	<u>Iron (Fe), Cobalt (Co), and Nickel (Ni)</u>
	<u>Period 5</u>	<u>Ruthenium (Ru), Rhodium (Rh), and Palladium (Pd)</u>
	<u>Period 6</u>	<u>Osmium (Os), Iridium (Ir), and Platinum (Pt)</u>
<u>IIIB</u>	<u>Rare Earths</u>	<u>All</u>

2 – 7 (Canceled) Without prejudice.

8. (Currently amended) The process of claim 1, further comprising adding stabilizing compounds to the electrolyte for overcoming and stabilizing the short lifetime of oxidized forms of higher oxidation state species of the mediator oxidizing species, and further comprising additives disposed in the electrolyte thereby increasing the kinetics of the mediated electrochemical processes of the mediated electrochemical processes while keeping it from becoming directly involved in the oxidizing of the waste and/or inorganic materials, and stabilizer compounds disposed in the electrolyte for stabilizing higher oxidation state species of oxidized forms of the reversible redox couples used as the mediator oxidizing species in the electrolyte.

9. (Canceled) Without prejudice.

10. (Currently Amended) The process of claim 1, wherein the mediator oxidizing species are super oxidizers which exhibit oxidation potentials of at least 1.7 volts at 1 molar, 25°C and pH 1 and which are redox couple species that have the capability of producing free radicals of hydroxyl or perhydroxyl, and further comprising creating free radical secondary oxidizers by reacting the super oxidizers with water, adding energy from an energy source, ultrasonic and/or ultraviolet, to the anolyte portion and augmenting the secondary oxidation processes, breaking down hydrogen peroxide in the anolyte portion into hydroxyl free radicals, and increasing an oxidizing effect of the secondary oxidation processes, and further comprising generating inorganic free radicals in aqueous solutions from a group consisting of carbonate, azide, nitrite, nitrate, phosphite, phosphate, sulfite, sulfate, selenite, thiocyanate, chloride, bromide, iodide, and formate oxidizing species and combinations thereof.

11. (Original) The process of claim 1, further comprising using an alkaline solution, aiding decomposing of the biological materials in waste and/or inorganic materials derived from base promoted ester hydrolysis, saponification, of fatty acids, and forming water soluble alkali metal salts of the fatty acids and glycerin in a process similar to the production of soap from animal fat by introducing it into a hot aqueous lye solution.

12. (Currently Amended) The process of claim 1, further comprising using an alkaline anolyte solution for aiding decomposing the materials, for absorbing CO₂ from the oxidizing of waste and/or inorganic materials and forming alkali metal bicarbonate/carbonate solutions, which subsequently circulate through the electrochemical cell, producing percarbonate oxidizers.

13 – 14 (Canceled) Without prejudice.

15. (Original) The process of claim 1, further comprising impressing an AC voltage upon the direct current voltage for retarding formation of cell performance limiting surface films on the electrodes or the membrane.

16 – 18 (Canceled) Without prejudice.

19. (Original) The process of claim 1, further comprising adjusting temperature between 0°C and slightly below the boiling point of the anolyte portion before it enters the electrochemical cell for enhancing generation of oxidized forms of the mediator oxidizing species, and adjusting the temperature between 0°C and below the boiling temperature of the anolyte portion entering the anolyte reaction chamber affecting desired chemical reactions at desired rates.

20. (Currently Amended) The process of claim 1, further comprising introducing an ultrasonic energy into the anolyte portion, rupturing cell membranes in the biological materials in waste and/or inorganic materials by momentarily raising local temperature and pressure within

the cell membranes with the ultrasonic energy to above several thousand degrees and thousand atmospheres, and causing cell membrane failure, and wherein the added energy comprises using ultrasonic energy and inducing microscopic bubble expansion and implosion for reducing in size individual second phase mixed waste volumes dispersed in the anolyte.

21. (Original) The process of claim 1, further comprising inorganic waste containing elements that are identified in Table I as anion redox couples, they become possible mediated redox couples when the oxidation of the inorganic waste releases them into solution as the reduced form of the redox couple and are raised to the oxidized form when they pass through the electrochemical cell.

22. (Currently Amended) The process of claim 1, further comprising introducing ultraviolet energy into the anolyte portion and decomposing hydrogen peroxide into hydroxyl free radicals therein, thereby increasing efficiency of the process by converting products of electron consuming parasitic reactions, ~~ozone and~~ hydrogen peroxide, into viable free radical secondary oxidizers without consumption of additional electrons.

23. (Original) The process of claim 1, further comprising adding a surfactant to the anolyte portion for promoting dispersion of the waste and/or inorganic materials or intermediate stage reaction products within the aqueous solution when the waste and/or inorganic materials or reaction products are not water-soluble and tend to form immiscible layers.

24. (Original) The process of claim 1, further comprising attacking specific organic molecules in the waste and/or inorganic materials with the mediator oxidizing species while operating at a sufficiently low temperatures and preventing formation of dioxins and furans.

25. (Original) The process of claim 1, further comprising breaking down the waste and/or inorganic materials into biological and organic compounds and attacking these

compounds using as the mediator simple and/or complex anion redox couple mediators or inorganic free radicals and generating organic free radicals.

26. (Original) The process of claim 1, further comprising raising normal valence state mediator anions to a higher valence state by stripping the mediator anions of electrons in the electrochemical cell, wherein oxidized forms of weaker redox couples present in the mediator oxidizing species are produced by similar anodic oxidation or reaction with oxidized forms of stronger redox couples present and the oxidized species of the redox couples oxidize molecules of the waste and/or inorganic materials and are themselves converted to their reduced form, whereupon they are oxidized by the aforementioned mechanisms and the redox cycle continues.

27. (Currently Amended) A process for treating and waste comprising oxidizing waste and/or inorganic materials ~~by~~, comprising circulating anions of mediator oxidizing species in an electrolyte through an electrochemical cell with an ion-selective membrane, semi permeable, microporous polymer, ceramic or glass frit membrane, and affecting anodic oxidation of reduced forms of reversible redox couples into oxidized forms, contacting the anions with the waste and/or inorganic materials in an anolyte portion of the electrolyte in a primary oxidation process, involving super oxidizer anions, having an oxidation potential above a threshold value of 1.7 volts at 1 molar, 25°C and pH1 are present there is creating a free radical oxidizer driven secondary oxidation process, adding energy from an energy source to the anolyte portion and augmenting the secondary oxidation processes, breaking down hydrogen peroxide in the anolyte portion into hydroxyl free radicals, and increasing an oxidizing effect of the secondary oxidation processes, wherein the mediator oxidizing species are simple anion redox couples described in Table I as below; Type I isopolyanions complex anion redox couples formed by incorporation of Mo, W, V, Nb, Ta, or mixtures thereof as

addenda atoms; Type I heteropolyanions complex anion redox couples formed by incorporation in to Type I isopolyanions as heteroatoms any of the elements listed in Table II either singly or in combination thereof, or heteropolyanions complex anion redox couples containing at least one heteroatom type element contained in both Table I and Table II below or combinations of the mediator oxidizing species from any or all of these generic groups:

Table I: Simple Anion Redox Couples

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
I	A	None			
	B	Copper (Cu)	+2	Cu ⁺² (cupric)	+2 Species/ +3, +4 Species; +3 Species/ +4 Species
				HCuO ₂ (bicuprite)	
				CuO ₂ ⁻² (cuprite)	
			+3	Cu ⁺³	
				CuO ₂ ⁻ (cuprate)	
				Cu ₂ O ₃ (sesquioxide)	
			+4	CuO ₂ (peroxide)	
		Silver (Ag)	+1	Ag ⁺ (argentous)	+1 Species/ +2, +3 Species; +2 Species/ +3 Species
				AgO ⁻ (argentite)	
			+2	Ag ⁺² (argentic)	
				AgO (argentic oxide)	
			+3	AgO ⁺ (argetyl)	
				Ag ₂ O ₃ (sesquioxide)	
		Gold (Au)	+1	Au ⁺ (aurous)	+1 Species/ +3, +4 Species; + 3 Species/ +4 Species
			+3	Au ⁺³ (auric)	
				AuO ⁻ (auryl)	
				H ₃ AuO ₃ ⁻ (auric acid)	
II	A	Magnesium (Mg)	+2	Mg ⁺² (magnesium)	+2 Species/ +4 Species
			+4	MgO ₂ (peroxide)	
		Calcium (Ca)	+2	Ca ⁺²	+2 Species/ +4 Species
			+4	CaO ₂ (peroxide)	
		Strontium	+2	Sr ⁺²	+2 Species/ +4 Species
			+4	SrO ₂ (peroxide)	
		Barium (Ba)	+2	Ba ⁺²	+2 Species/ +4 Species
			+4	BaO ₂ (peroxide)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
II	B	Zinc (Zn)	+2	Zn^{+2} (zincic)	+2 Species/ +4 Species
				ZnOH^+ (zincyl) HZnO_2^- (bizincate) ZnO_2^{-2} (zincate)	
			+4	ZnO_2 (peroxide)	
		Mercury (Hg)	+2	Hg^{+2} (mercuric) $\text{Hg}(\text{OH})_2$ (mercuric hydroxide) HHgO_2^- (mercuroate)	+2 Species/ +4 Species
			+4	HgO_2 (peroxide)	
III	A	Boron	+3	H_3BO_3 (orthoboric acid) H_2BO_3^- , HBO_3^{-2} , BO_3^{-3} (orthoborates) BO_2^- (metaborate) $\text{H}_2\text{B}_4\text{O}_7$ (tetraboric acid) $\text{HB}_4\text{O}_7^-/\text{B}_4\text{O}_7^{-2}$ (tetraborates) $\text{B}_2\text{O}_4^{-2}$ (diborate) $\text{B}_6\text{O}_{10}^{-2}$ (hexaborate)	+3 Species/ +4.5, +5 Species
			+4.5	B_2O_5^- (diborate)	
			+5	$\text{BO}_3^-/\text{BO}_2 \cdot \text{H}_2\text{O}$ (perborate)	
		Thallium (Tl)	+1	Tl^{+1} (thallous)	+1 Species/ +3 or +3.33 Species;
			+3	Tl^{+3} (thallic) TlO^+ , TlOH^{+2} , $\text{Tl}(\text{OH})_2^+$ (thallyl) Tl_2O_3 (sesquioxide) $\text{Tl}(\text{OH})_3$ (hydroxide)	+3 Species/ +3.33 Species
			+3.33	Tl_3O_5 (peroxide)	
	B	See Rare Earths and Actinides			

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
IV	A	Carbon (C)	+4	<u>H₂CO₃ (carbonic acid)</u> <u>HCO₃⁻ (bicarbonate)</u> <u>CO₃⁻² (carbonate)</u>	<u>+4 Species/</u> <u>+5, +6 Species</u>
			+5	<u>H₂C₂O₆ (perdicarbonic acid)</u>	
			+6	<u>H₂CO₄ (permonocarbonic acid)</u>	
		Germanium (Ge)	+4	<u>H₂GeO₃ (germanic acid)</u> <u>HGeO₃⁻ (bigermaniate)</u> <u>GeO₃⁻⁴ (germinate)</u> <u>Ge⁺⁴ (germanic)</u> <u>GeO₄⁻⁴</u> <u>H₂Ge₂O₅ (digermanic acid)</u> <u>H₂Ge₄O₉ (tetragermanic acid)</u> <u>H₂Ge₅O₁₁ (pentagermanic acid)</u> <u>HGe₅O₁₁⁻ (bipentagermanate)</u>	<u>+4 Species/</u> <u>+6 Species</u>
			+6	<u>Ge₅O₁₁⁻² (pentagermanate)</u>	
		Tin (Sn)	+4	<u>Sn⁺⁴ (stannic)</u> <u>HSnO₃⁻ (bistannate)</u> <u>SnO₃⁻² (stannate)</u> <u>SnO₂ (stannic oxide)</u> <u>Sn(OH)₄ (stannic hydroxide)</u>	<u>+4 Species/</u> <u>+7 Species</u>
			+7	<u>SnO₄⁻ (perstannate)</u>	
		Lead (Pb)	+2	<u>Pb⁺² (plumbous)</u> <u>HPbO₂⁻ (biplumbite)</u> <u>PbOH⁺</u> <u>PbO₂⁻² (plumbite)</u> <u>PbO (plumbus oxide)</u>	<u>+2, +2.67, +3</u> <u>Species/+4</u> <u>Species</u>
			+2.67	<u>Pb₃O₄ (plumbo-plumbic oxide)</u>	
			+3	<u>Pb₂O₃ (sequioxide)</u>	
		Lead (Pb)	+4	<u>Pb⁺⁴ (plumbic)</u>	<u>+2, +2.67, +3</u> <u>Species/+4</u> <u>Species</u>
				<u>PbO₃⁻² (metaplumbate)</u>	
				<u>HPbO₃⁻ (acid metaplumbate)</u>	
				<u>PbO₄⁻⁴ (orthoplumbate)</u>	
				<u>PbO₂ (dioxide)</u>	
IV	A				

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
<u>IV</u>	<u>B</u>	<u>Titanium</u>	<u>+4</u>	<u>TiO⁺²</u> (pertitanyl) <u>HTiO₄⁻</u> (titanate) <u>TiO₂</u> (dioxide)	<u>+4 Species/</u> <u>+6 Species</u>
			<u>+6</u>	<u>TiO₂⁺²</u> (pertitanyl) <u>HTiO₄⁻</u> (acid pertitanate) <u>TiO₄⁻²</u> (pertitanate) <u>TiO₃</u> (peroxide)	
		<u>Zirconium (Zr)</u>	<u>+4</u>	<u>Zr⁺⁴</u> (zirconic) <u>ZrO⁺²</u> (zirconyl) <u>HZrO₃⁻</u> (zirconate)	<u>+4 Species/ +5,</u> <u>+6, +7 Species</u>
			<u>+5</u>	<u>Zr₂O₅</u> (pentoxide)	
			<u>+6</u>	<u>ZrO₃</u> (peroxide)	
			<u>+7</u>	<u>Zr₂O₇</u> (heptoxide)	
		<u>Hafnium (Hf)</u>	<u>+4</u>	<u>Hf⁺⁴</u> (hafnic) <u>HfO⁺²</u> (hafnyl)	<u>+4 Species/</u> <u>+6 Species</u>
			<u>+6</u>	<u>HfO₃</u> (peroxide)	
<u>V</u>	<u>A</u>	<u>Nitrogen</u>	<u>+5</u>	<u>HNO₃</u> (nitric acid) <u>NO₃⁻</u> (nitrate)	<u>+5 species/</u> <u>+7 Species</u>
			<u>+7</u>	<u>HNO₄</u> (pernitric acid)	
		<u>Phosphorus (P)</u>	<u>+5</u>	<u>H₃PO₄</u> (orthophosphoric acid) <u>H₂PO₄⁻</u> (monoorthophosphate) <u>HPO₄⁻²</u> (diorthophosphate) <u>PO₄⁻³</u> (triorthophosphate) <u>HPO₃</u> (metaphosphoric acid) <u>H₄P₂O₇</u> (pyrophosphoric acid) <u>H₅P₃O₁₀</u> (triphosphoric acid) <u>H₆P₄O₁₃</u> (tetraphosphoric acid)	<u>+5 Species/</u> <u>+6, +7 species</u>
<u>V</u>	<u>A</u>	<u>Phosphorus (P)</u>	<u>+6</u>	<u>H₄P₂O₈</u> (perphosphoric acid)	<u>+5 Species/</u> <u>+6, +7 Species</u>
			<u>+7</u>	<u>H₃PO₅</u> (monoperphosphoric acid)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
<u>V</u>	<u>A</u>	<u>Arsenic (As)</u>	<u>+5</u>	<u>H₃AsO₄ (ortho-arsenic acid)</u> <u>H₂AsO₄⁻ (mono ortho-arsenate)</u> <u>HAsO₄⁻² (di-ortho-arsenate)</u> <u>AsO₄⁻³ (tri-ortho-arsenate)</u> <u>AsO₂⁺ (arsenyl)</u>	<u>+5 Species/</u> <u>+7 species</u>
			<u>+7</u>	<u>AsO₃⁺ (perarsenyl)</u>	
		<u>Bismuth (Bi)</u>	<u>+3</u>	<u>Bi⁺³ (bismuthous)</u> <u>BiOH⁺² (hydroxybismuthous)</u> <u>BiO⁺ (bismuthyl)</u> <u>BiO₂⁻ (metabismuthite)</u>	<u>+3 Species/</u> <u>+3.5, +4, +5</u> <u>Species</u>
			<u>+3.5</u>	<u>Bi₄O₇ (oxide)</u>	
			<u>+4</u>	<u>Bi₂O₄ (tetroxide)</u>	
			<u>+5</u>	<u>BiO₃⁻ (metabismuthite)</u> <u>Bi₂O₅ (pentoxide)</u>	
	<u>B</u>	<u>Vanadium (V)</u>	<u>+5</u>	<u>VO₂⁺ (vanadic)</u> <u>H₃V₂O₇⁻ (pyrovanadate)</u> <u>H₂VO₄⁻ (orthovanadate)</u> <u>VO₃⁻ (metavanadate)</u> <u>HVO₄⁻² (orthovanadate)</u> <u>VO₄⁻³ (orthovanadate)</u> <u>V₂O₅ (pentoxide)</u> <u>H₄V₂O₇ (pyrovanadic acid)</u> <u>HVO₃ (metavanadic acid)</u> <u>H₄V₆O₁₇ (hexavanadic acid)</u>	<u>+5 Species/</u> <u>+7, +9 Species</u>
			<u>+7</u>	<u>VO₄⁻ (pervanadate)</u>	
			<u>+9</u>	<u>VO₅⁻ (hypervanadate)</u>	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES		
V	B	Niobium (Nb)	+5	NbO ₃ ⁻ (metaniobate) NbO ₄ ⁻³ (orthoniobate) Nb ₂ O ₅ (pentoxide) HNbO ₃ (niobid acid)	+5 Species/ +7 species		
			+7	NbO ₄ ⁻ (perniobate) Nb ₂ O ₇ (perniobic oxide) HNbO ₄ (perniobic acid)			
			Tantalum (Ta)	+5	TaO ₃ ⁻ (metatantalate) TaO ₄ ⁻³ (orthotantalate) Ta ₂ O ₅ (pentoxide) HTaO ₃ (tantalic acid)	+5 species/ +7 species	
				+7	TaO ₄ ⁻ (pentantalate) Ta ₂ O ₇ (pertantalate) HTaO ₄ •H ₂ O (pertantalic acid)		
				Sulfur (S)	+6	H ₂ SO ₄ (sulfuric acid) HSO ₄ ⁻ (bisulfate) SO ₄ ⁻² (sulfate)	+6 Species/ +7, +8 Species
					+7	S ₂ O ₈ ⁻² (dipersulfate)	
		+8	H ₂ SO ₅ (momopersulfuric acid)				
		Selenium (Se)	+6		H ₂ Se ₂ O ₄ (selenic acid) HSeO ₄ ⁻ (biselenate) SeO ₄ ⁻² (selenate)	+6 species/ +7 Species	
			+7		H ₂ Se ₂ O ₈ (perdiselenic acid)		
			Tellurium (Te)		+6	H ₂ TeO ₄ (telluric acid) HTeO ₄ ⁻ (bitellurate) TeO ₄ ⁻² (tellurate)	+6 species/ +7 species
+7	H ₂ Te ₂ O ₈ (perditellenic acid)						
Polonium (Po)	+2	Po ⁺² (polonous)		+2, +4 species/ +6 Species			
	+4	PoO ₃ ⁻² (polonate)					
	+6	PoO ₃ (peroxide)					

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VI	B	Chromium	+3	Cr^{+3} (chromic) CrOH^{+2} , $\text{Cr}(\text{OH})_2^+$ (chromyls) CrO_2^- , CrO_3^{-3} (chromites) Cr_2O_3 (chromic oxide) $\text{Cr}(\text{OH})_3$ (chromic hydroxide)	+3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+4	CrO_2 (dioxide) $\text{Cr}(\text{OH})_4$ (hydroxide)	
			+6	H_2CrO_4 (chromic acid) HCrO_4^- (acid chromate) CrO_4^{-2} (chromate) $\text{Cr}_2\text{O}_7^{-2}$ (dichromate)	
		Molybdenum (Mo)	+6	HMoO_4^- (bimolybdate) MoO_4^{-2} (molybdate) MoO_3 (molybdic trioxide) H_2MoO_4 (molybolic acid)	+6 Species/ +7 Species
			+7	MoO_4^- (permolybdate)	
		Tungsten (W)	+6	WO_4^{-2} tungstic) WO_3 (trioxide) H_2WO_4 (tungstic acid)	+6 Species/ +8 Species
			+8	WO_5^{-2} (pertungstic) H_2WO_5 (pertungstic acid)	
VII	A	Chlorine (Cl)	+1	HClO (hypochlorous acid) ClO^- (hypochlorite)	+1 Species/ +3, +5, +7 Species; +3 Species/ +5, +7 Species;
			+3	HClO_2 (chlorous acid) ClO_2^- (chlorite)	+5 Species/ +7 Species
			+5	HClO_3 (chloric acid) ClO_3^- (chlorate)	
			+7	HClO_4 (perchloric acid) ClO_4^- , HClO_5^{-2} , ClO_5^{-3} , $\text{Cl}_2\text{O}_9^{-4}$ (perchlorates)	

<u>GROUP</u>	<u>SUB GROU P</u>	<u>ELEMENT</u>	<u>VALENCE</u>	<u>SPECIES</u>	<u>SPECIFIC REDOX COUPLES</u>
VII	A	<u>Bromine (Br)</u>	<u>+1</u>	<u>HBrO (hypobromous acid)</u> <u>BrO⁻ (hypobromite)</u>	<u>+1 Species/+3,</u> <u>+5, +7 Species;</u> <u>+3 Species/ +5,</u> <u>+7 Species;</u> <u>+5 Species/ +7</u> <u>Species</u>
			<u>+3</u>	<u>HBrO₂ (bromous acid)</u> <u>BrO₂⁻ (bromite)</u>	
			<u>+5</u>	<u>HBrO₃ (bromic acid)</u> <u>BrO₃⁻ (bromate)</u>	
			<u>+7</u>	<u>HBrO₄ (perbromic acid)</u> <u>BrO₄⁻, HBrO₅⁻², BrO₅⁻³, Br₂O₉⁻⁴</u> <u>(prebromates)</u>	
		<u>Iodine</u>	<u>+1</u>	<u>HIO (hypoiodous acid)</u> <u>IO⁻ (hypoiodite)</u>	<u>+1 Species/+3,</u> <u>+5, +7 Species;</u> <u>+3 Species/ +5,</u> <u>+7 Species;</u> <u>+5 Species/ +7</u> <u>Species</u>
			<u>+3</u>	<u>HIO₂ (iodous acid)</u> <u>IO₂⁻ (iodite)</u>	
			<u>+5</u>	<u>HIO₃ (iodic acid)</u> <u>IO₃⁻ (iodate)</u>	
			<u>+7</u>	<u>HIO₄ (periodic acid)</u> <u>IO₄⁻, HIO₅⁻², IO₅⁻³, I₂O₉⁻⁴</u> <u>(periodates)</u>	
	B	<u>Manganese (Mn)</u>	<u>+2</u>	<u>Mn⁺² (manganeous)</u> <u>HMnO₂⁻ (dimanganite)</u>	<u>+2 Species/ +3,</u> <u>+4, +6, +7</u> <u>Species;</u> <u>+3 Species/ +4,</u> <u>+6, +7 Species;</u> <u>+4 Species/ +6,</u> <u>+7 Species;</u> <u>+6 Species/ +7</u> <u>Species</u>
			<u>+3</u>	<u>Mn⁺³ (manganic)</u>	
			<u>+4</u>	<u>MnO₂ (dioxide)</u>	
			<u>+6</u>	<u>MnO₄⁻² (manganate)</u>	
			<u>+7</u>	<u>MnO₄⁻ (permanganate)</u>	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VIII	Period 4	Iron (Fe)	+3	Fe^{+3} (ferric) $\text{Fe}(\text{OH})^{+2}$ $\text{Fe}(\text{OH})_2^{+}$ FeO_2^{-2} (ferrite)	+3 Species/+4, +5, +6 Species;
VIII	Period 4	Iron (Fe)	+4	FeO^{+2} (ferryl) FeO_2^{-2} (perferrite)	+4 Species/ +5, +6 Species; +5 Species/ +6 Species
			+5	FeO_2^{+} (perferryl)	
			+6	FeO_3^{-2} (ferrate)	
		Cobalt (Co)	+2	Co^{+2} (cobalous) HCoO_2^{-} (dicobaltite)	+2 Species/ +3, +4 Species; +3 Species/ +4 Species
			+3	Co^{+3} (cobaltic) Co_2O_3 (cobaltic oxide)	
			+4	CoO_2 (peroxide) H_2CoO_3 (cobaltic acid)	
		Nickel (Ni)	+2	Ni^{+2} (nickelous) NiOH^{+} HNiO_2^{-} (dinickelite) NiO_2^{-2} (nickelite)	+2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+3	Ni^{+3} (nickelic) Ni_2O_3 (nickelic oxide)	
			+4	NiO_2 (peroxide)	
			+6	NiO_4^{-2} (nickelate)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VIII	Period 5	<u>Ruthenium (Ru)</u>	<u>+2</u>	<u>Ru⁺²</u>	<u>+2 Species/ +3, +4, +5, +6, +7, +8 Species;</u>
			<u>+3</u>	<u>Ru⁺³</u> <u>Ru₂O₃ (sesquioxide)</u> <u>Ru(OH)₃ (hydroxide)</u>	<u>+3 Species/ +4, +5, +6, +7, +8 Species;</u> <u>+4 Species/ +5, +6, +7, +8 Species;</u> <u>+5 Species/ +6, +7, +8 Species;</u>
			<u>+4</u>	<u>Ru⁺⁴ (ruthenic)</u> <u>RuO₂ (ruthenic dioxide)</u> <u>Ru(OH)₄ (ruthenic hydroxide)</u>	<u>+6 Species/ +7, +8 Species;</u> <u>+7 Species/ +8 Species</u>
			<u>+5</u>	<u>Ru₂O₅ (pentoxide)</u>	
			<u>+6</u>	<u>RuO₄⁻² (ruthenate)</u> <u>RuO₂⁺² (ruthenyl)</u> <u>RuO₃ (trioxide)</u>	
			<u>+7</u>	<u>RuO₄⁻ (perruthenate)</u>	
			<u>+8</u>	<u>H₂RuO₄ (hyperuthenic acid)</u> <u>HRuO₅⁻ (diperruthenate)</u> <u>RuO₄ (ruthenium tetroxide)</u>	
		<u>Rhodium (Rh)</u>	<u>+1</u>	<u>Rh⁺ (hyporhodos)</u>	<u>+1 Species/ +2, +3, +4, +6 Species;</u>
			<u>+2</u>	<u>Rh⁺² (rhodous)</u>	<u>+2 Species/ +3, +4, +6 Species;</u>
			<u>+3</u>	<u>Rh⁺³ (rhodic)</u> <u>Rh₂O₃ (sesquioxide)</u>	<u>+3 Species/ +4, +6 Species;</u> <u>+4 Species/ +6 Species</u>
			<u>+4</u>	<u>RhO₂ (rhodic oxide)</u> <u>Rh(OH)₄ (hydroxide)</u>	
			<u>+6</u>	<u>RhO₄⁻² (rhodate)</u> <u>RhO₃ (trioxide)</u>	
		<u>Palladium</u>	<u>+2</u>	<u>Pd⁺² (palladous)</u> <u>PdO₂⁻² (palladite)</u>	<u>+2 Species/ +3, +4, +6 Species;</u> <u>+3 Species/ +4, +6 Species;</u>
			<u>+3</u>	<u>Pd₂O₃ (sesquioxide)</u>	<u>+4 Species/ +6 Species</u>
			<u>+4</u>	<u>Pd O₃⁻² (palladate)</u> <u>PdO₂ (dioxide)</u> <u>Pd(OH)₄ (hydroxide)</u>	
			<u>+6</u>	<u>PdO₃ (peroxide)</u>	

<u>GROUP</u>	<u>SUB GROUP</u>	<u>ELEMENT</u>	<u>VALENCE</u>	<u>SPECIES</u>	<u>SPECIFIC REDOX COUPLES</u>
<u>VIII</u>	<u>Period 6</u>	<u>Iridium (Ir)</u>	<u>+3</u>	<u>Ir⁺³ (iridic)</u> <u>Ir₂O₃ (iridium sesquioxide)</u> <u>Ir (OH)₃ (iridium hydroxide)</u>	<u>+3 Species/</u> <u>+4, +6 Species;</u> <u>+4 Species/</u> <u>+6 Species</u>
			<u>+4</u>	<u>IrO₂ (iridic oxide)</u> <u>Ir (OH)₄ (iridic hydroxide)</u>	
			<u>+6</u>	<u>IrO₄⁻² (iridate)</u> <u>IrO₃ (iridium peroxide)</u>	
		<u>Platinum (Pt)</u>	<u>+2</u>	<u>Pt⁺² (platinous)</u>	<u>+2, +3 Species/</u> <u>+4, +6 Species;</u> <u>+4 Species/</u> <u>+6 Species</u>
			<u>+3</u>	<u>Pt₂O₃ (sesquioxide)</u>	
			<u>+4</u>	<u>PtO₃⁻² (palatinate)</u> <u>PtO⁺² (platynyl)</u> <u>Pt(OH)⁺³</u> <u>PtO₂ (platinic oxide)</u>	
			<u>+6</u>	<u>PtO₄⁻² (perplatinate)</u> <u>PtO₃ (perplatonic oxide)</u>	
<u>IIIB</u>	<u>Rare earths</u>	<u>Cerium (Ce)</u>	<u>+3</u>	<u>Ce⁺³ (cerous)</u> <u>Ce₂O₃ (cerous oxide)</u> <u>Ce(OH)₃ (cerous hydroxide)</u>	<u>+3 Species/</u> <u>+4, +6 Species;</u> <u>+4 Species/</u> <u>+6 Species</u>
			<u>+4</u>	<u>Ce⁺⁴, Ce(OH)⁺³, Ce(OH)₂⁺², Ce(OH)₃⁺ (ceric)</u> <u>CeO₂ (ceric oxide)</u>	
			<u>+6</u>	<u>CeO₃ (peroxide)</u>	
		<u>Praseodymium (Pr)</u>	<u>+3</u>	<u>Pr⁺³ (praseodymous)</u> <u>Pr₂O₃ (sesquioxide)</u> <u>Pr(OH)₃ (hydroxide)</u>	<u>+3 species/ +4 species</u>
			<u>+4</u>	<u>Pr⁺⁴ (praseodymic)</u> <u>PrO₂ (dioxide)</u>	
		<u>Neodymium</u>	<u>+3</u>	<u>Nd⁺³</u> <u>Nd₂O₃ (sesquioxide)</u>	<u>+3 Species/ +4 Species</u>
			<u>+4</u>	<u>NdO₂ (peroxide)</u>	
		<u>Terbium (Tb)</u>	<u>+3</u>	<u>Tb⁺³</u> <u>Tb₂O₃ (sesquioxide)</u>	<u>+3 Species/ +4 Species</u>
			<u>+4</u>	<u>TbO₂ (peroxide)</u>	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
IIIB	Actinides	Thorium (Th)	+4	Th ⁺⁴ (thoric) ThO ⁺² (thoryl) HThO ₃ ⁻ (thorate)	+4 Species/ +6 Species
			+6	ThO ₃ (acid peroxide)	
		Uranium (U)	+6	UO ₂ ⁺² (uranyl) UO ₃ (uranic oxide)	+6 Species/ +8 Species
			+8	HUO ₅ ⁻ , UO ₅ ⁻² (peruranates) UO ₄ (peroxide)	
		Neptunium (Np)	+5	NpO ₂ ⁺ (hyponeptunyl) Np ₂ O ₅ (pentoxide)	+5 Species/ +6, +8 Species; +6 Species/ +8 Species
			+6	NpO ₂ ⁺² (neptunyl) NpO ₃ (trioxide)	
			+8	NpO ₄ (peroxide)	
		Plutonium (Pu)	+3	Pu ⁺³ (hypoplutinous)	+3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species
			+4	Pu ⁺⁴ (plutinous) PuO ₂ (dioxide)	
			+5	PuO ₂ ⁺ (hypoplutonyl) Pu ₂ O ₅ (pentoxide)	
			+6	PuO ₂ ⁺² (plutonyl) PuO ₃ (peroxide)	
		Americium (Am)	+3	Am ⁺³ (hypoamericous)	+3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species
			+4	Am ⁺⁴ (americous) AmO ₂ (dioxide) Am(OH) ₃ (hydroxide)	
			+5	AmO ₂ ⁺ (hypoamericyl) Am ₂ O ₅ (pentoxide)	
			+6	AmO ₂ ⁺² (americyl) AmO ₃ (peroxide)	

Table II: Elements Participating as Heteroatoms in Heteropolyanion Complex Anion Redox Couple Mediators

<u>GROUP</u>	<u>SUB GROUP</u>	<u>ELEMENT</u>
<u>I</u>	<u>A</u>	<u>Lithium (Li), Sodium (Na), Potassium (K), and Cesium (Cs)</u>
	<u>B</u>	<u>Copper (Cu), Silver (Ag), and Gold (Au)</u>
<u>II</u>	<u>A</u>	<u>Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), and Barium (Ba)</u>
	<u>B</u>	<u>Zinc (Zn), Cadmium (Cd), and Mercury (Hg)</u>
<u>III</u>	<u>A</u>	<u>Boron (B), and Aluminum (Al)</u>
	<u>B</u>	<u>Scandium (Sc), and Yttrium (Y) – (See Rare Earths)</u>
<u>IV</u>	<u>A</u>	<u>Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb)</u>
	<u>B</u>	<u>Titanium (Ti), Zirconium (Zr), and Hafnium (Hf)</u>
<u>V</u>	<u>A</u>	<u>Nitrogen (N), Phosphorous (P), Arsenic (As), Antimony (Sb), and Bismuth (Bi)</u>
	<u>B</u>	<u>Vanadium (V), Niobium (Nb), and Tantalum (Ta)</u>
<u>VI</u>	<u>A</u>	<u>Sulfur (S), Selenium (Se), and Tellurium (Te)</u>
	<u>B</u>	<u>Chromium (Cr), Molybdenum (Mo), and Tungsten (W)</u>
<u>VII</u>	<u>A</u>	<u>Fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I)</u>
	<u>B</u>	<u>Manganese (Mn), Technetium (Tc), and Rhenium (Re)</u>
<u>VIII</u>	<u>Period 4</u>	<u>Iron (Fe), Cobalt (Co), and Nickel (Ni)</u>
	<u>Period 5</u>	<u>Ruthenium (Ru), Rhodium (Rh), and Palladium (Pd)</u>
	<u>Period 6</u>	<u>Osmium (Os), Iridium (Ir), and Platinum (Pt)</u>
<u>IIIB</u>	<u>Rare Earths</u>	<u>All</u>

28 – 29 (Canceled) Without prejudice.

30. (Currently Amended) The process of claim 27, wherein the adding energy comprises introducing an ultrasonic energy source and/or an ultraviolet energy source into the anolyte portion, promoting the formation of the hydroxyl free radicals, wherein the added energy comprises using ultrasonic energy and inducing microscopic bubble expansion and implosion for reducing in size individual second phase waste and/or inorganic materials volumes dispersed in the anolyte.

31 (Canceled) Without prejudice.

32. (Currently Amended) The process of ~~claim 27~~ claim 1, further comprising using the mediator oxidizing species that are found in situ in the waste and/or inorganic materials to be decomposed, by circulating the waste and/or inorganic materials-anolyte mixture through the electrochemical cell where in an oxidized form of an in situ reversible redox couple is formed by anodic oxidizing or reacting with an oxidized form of a more powerful redox couple added to or already present in the anolyte portion and anodically oxidized in the electrochemical cell, thereby destroying the biological and organic materials in the waste and/or inorganic materials.

33. (Original) The process of claim 27, further comprising using an alkaline electrolyte selected from a group consisting of NaOH or KOH and combinations thereof, with the mediator oxidizing species, wherein a reduced form of a mediator redox couple has sufficient solubility in said electrolyte for allowing desired oxidation of the biological and organic materials in the waste and/or inorganic materials.

34. (Currently Amended) The process of ~~claim 27~~ claim 1, wherein the oxidation potential of redox reactions of the mediator oxidizing species and the biological and organic molecules in the waste and/or inorganic materials producing hydrogen ions are inversely

proportional to electrolyte pH, and thus with a selection of a mediator redox couple increasing the electrolyte pH reduces the electric potential required, thereby reducing electric power consumed per unit mass of the waste and/or inorganic materials destroyed.

35. (Currently Amended) The process of claim 27, wherein the electrolyte is an aqueous solution chosen from the group consisting of acids, alkalines and ~~neutral~~ salt electrolytes and mixtures of salt and either acids or alkalines and combinations thereof.

36 (Canceled) Without prejudice.

37. (Currently Amended) The process of claim 27, further comprising interchanging the mediator oxidizing species without changing equipment, and wherein the anolyte and catholyte portions of electrolyte are independent of one another and comprise aqueous solutions selected from the group consisting of acids, alkali or salts ~~the electrolyte is an acid, neutral or alkaline aqueous solution~~ or mixtures of salt and either acids or alkalines and combinations thereof.

38 – 42 (Canceled) Without prejudice.

43. (Currently Amended) The process of claim 27, wherein the oxidizing and destroying waste and/or inorganic materials comprises destroying and oxidizing solid waste and/or inorganic materials, comprises oxidizing and destroying liquid waste and/or inorganic materials, comprises treating and oxidizing gas waste and/or inorganic materials, comprises oxidizing and destroying a combination of liquids, solids, and gases in waste and/or inorganic materials.

44 – 46 (Canceled) Without prejudice.

47. (Original) The process of claim 27, further comprising requiring removing and treating precipitates resulting from combinations of the oxidizing species and other species released from the waste and/or inorganic materials during destruction and sterilization.

48. (Currently Amended) The process of claim 27, further comprising a catholyte portion of the electrolyte, and wherein the anolyte and catholyte portions of electrolyte are independent of one another, and comprise aqueous solutions of selected from a group consisting of acids, alkali or ~~neutral~~ salt or a mixture of salt and either acids or alkali and combinations thereof.

49. (Currently Amended) The process of claim 27, further comprising separating a catholyte portion of the electrolyte from the anolyte portion with a membrane, operating the electrochemical cell at a ~~higher~~ current density ~~across the membrane, and near a limit over which~~ such that there is the possibility that metallic anions may leak through the membrane in small quantities, typically 0.5 amps per square centimeter of membrane or less, and recovering the metallic anions from the catholyte through a device such as a resin column, thus allowing a greater rate of destruction of waste and/or inorganic materials in the anolyte portion.

50. (Currently Amended) The process of claim 27, wherein the catholyte solution portion further comprises an aqueous solution and the electrolyte in the solution is composed of acids, alkali or ~~neutral~~ salts, and further comprising adding oxygen to this the solution when HNO_3 or NO_3^- can occur in the catholyte portion, controlling concentration of electrolyte in the catholyte to maintain conductivity of the catholyte portion desired in the electrochemical cell, providing mechanical mixing and/or ultrasonic energy induced microscopic bubble formation, and implosion for vigorous mixing in the catholyte solution for oxidizing the nitrous acid and small amounts of nitrogen oxides NO_x , introducing air into the catholyte portion for promoting

the oxidizing of the nitrous acid and the small amounts of NO_x, and diluting any hydrogen produced in the catholyte portion before releasing the air and hydrogen.

51. (Currently Amended) Apparatus for the use of mediated electrochemical oxidation (MEO) for the oxidation, conversion/recovery, and decontamination ~~(such as cleaning equipment and containers, etc.)~~ of all previously defined inorganic solid, liquid, or gas where higher oxidation states exist selected from a group consisting of ~~which includes, but is not limited to,~~ halogenated inorganic compounds (except fluorinated), inorganic pesticides and herbicides, inorganic fertilizers, carbon residues, incinerator residue, inorganic carbon compounds, mineral formations, mining tailings, inorganic salts, metals and metal compounds, and combinations thereof ~~etc.~~; and combined waste (e.g. a mixture of any of the foregoing with each other or other non-inorganic materials) further comprising an electrochemical cell, an aqueous electrolyte disposed in the electrochemical cell, a hydrogen or hydronium ion-permeable ~~or selective,~~ semi permeable, microporous polymer, ceramic or glass frit membrane, disposed in the electrochemical cell for separating the cell into anolyte and catholyte chambers and separating the electrolyte into aqueous anolyte and catholyte portions, electrodes further comprising an anode and a cathode disposed in the electrochemical cell respectively in the anolyte and catholyte chambers and in the anolyte and catholyte portions of the electrolyte, a power supply connected to the anode and the cathode for applying a direct current voltage between the anolyte and the catholyte portions of the electrolyte, and oxidizing of the materials in the anolyte portion with a mediated electrochemical oxidation (MEO) process wherein the anolyte portion further comprises a mediator in aqueous solution for producing reversible redox couples used as oxidizing species and the electrolyte is an acid, neutral or alkaline aqueous solution, wherein the mediator oxidizing species are simple anion redox couples described in

Table I as below; Type I isopolyanions complex anion redox couples formed by incorporation of Mo, W, V, Nb, Ta, or mixtures thereof as addenda atoms; Type I heteropolyanions complex anion redox couples formed by incorporation in to Type I isopolyanions as heteroatoms any of the elements listed in Table II either singly or in combination thereof, or heteropolyanions complex anion redox couples containing at least one heteroatom type element contained in both Table I and Table II below or combinations of the mediator oxidizing species from any or all of these generic groups:

Table I: Simple Anion Redox Couples

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
I	A	None			
	B	Copper (Cu)	+2	Cu^{+2} (cupric)	+2 Species/ +3, +4 Species; +3 Species/ +4 Species
				HCuO_2 (bicuprite) CuO_2^{-2} (cuprite)	
			+3	Cu^{+3} CuO_2^- (cuprate) Cu_2O_3 (sesquioxide)	
			+4	CuO_2 (peroxide)	
		Silver (Ag)	+1	Ag^+ (argentous) AgO^- (argentite)	+1 Species/ +2, +3 Species; +2 Species/ +3 Species
			+2	Ag^{+2} (argentic) AgO (argentic oxide)	
			+3	AgO^+ (argentlyl) Ag_2O_3 (sesquioxide)	
		Gold (Au)	+1	Au^+ (aurous)	+1 Species/ +3, +4 Species; + 3 Species/ +4 Species
			+3	Au^{+3} (auric) AuO^- (auryl) H_3AuO_3^- (auric acid) H_2AuO_3^- (monoaaurate) HAuO_3^{-2} (diaurate) AuO_3^{-3} (triaurate) Au_2O_3 (auric oxide) $\text{Au}(\text{OH})_3$ (auric hydroxide)	
			+4	AuO_2 (peroxide)	
II	A	Magnesium (Mg)	+2	Mg^{+2} (magnesian)	+2 Species/ +4 Species
			+4	MgO_2 (peroxide)	
		Calcium (Ca)	+2	Ca^{+2}	+2 Species/ +4 Species
			+4	CaO_2 (peroxide)	
		Strontium	+2	Sr^{+2}	+2 Species/ +4 Species
			+4	SrO_2 (peroxide)	
		Barium (Ba)	+2	Ba^{+2}	+2 Species/ +4 Species
			+4	BaO_2 (peroxide)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
II	B	Zinc (Zn)	+2	Zn^{+2} (zincic)	+2 Species/ +4 Species
				ZnOH^+ (zincyl) HZnO_2^- (bizincate) ZnO_2^{-2} (zincate)	
			+4	ZnO_2 (peroxide)	
			+2	Hg^{+2} (mercuric)	+2 Species/ +4 Species
		Mercury (Hg)		$\text{Hg}(\text{OH})_2$ (mercuric hydroxide) HHgO_2^- (mercuroate)	
III	A	Boron	+3	H_3BO_3 (orthoboric acid)	+3 Species/ +4.5, +5 Species
				H_2BO_3^- , HBO_3^{-2} , BO_3^{-3} (orthoborates) BO_2^- (metaborate) $\text{H}_2\text{B}_4\text{O}_7$ (tetraboric acid) $\text{HB}_4\text{O}_7^-/\text{B}_4\text{O}_7^{-2}$ (tetraborates) $\text{B}_2\text{O}_4^{-2}$ (diborate) $\text{B}_6\text{O}_{10}^{-2}$ (hexaborate)	
			+4.5	B_2O_5^- (diborate)	
			+5	$\text{BO}_3^-/\text{BO}_2^-\cdot\text{H}_2\text{O}$ (perborate)	
			+1	Tl^{+1} (thallous)	+1 Species/ +3 or +3.33 Species;
		Thallium (Tl)	+3	Tl^{+3} (thallic)	+3 Species/ +3.33 Species
				TlO^+ , TlOH^{+2} , $\text{Tl}(\text{OH})_2^+$ (thallyl) Tl_2O_3 (sesquioxide) $\text{Tl}(\text{OH})_3$ (hydroxide)	
			+3.33	Tl_3O_5 (peroxide)	
	B	See Rare Earths and Actinides			

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
IV	A	Carbon (C)	+4	H_2CO_3 (carbonic acid) HCO_3^- (bicarbonate) CO_3^{2-} (carbonate)	+4 Species/ +5, +6 Species
			+5	$\text{H}_2\text{C}_2\text{O}_6$ (perdicarbonic acid)	
			+6	H_2CO_4 (permonocarbonic acid)	
		Germanium (Ge)	+4	H_2GeO_3 (germanic acid) HGeO_3^- (bigermaniate) GeO_3^{4-} (germinate) Ge^{+4} (germanic) GeO_4^{4-} $\text{H}_2\text{Ge}_2\text{O}_5$ (digermanic acid) $\text{H}_2\text{Ge}_4\text{O}_9$ (tetragermanic acid) $\text{H}_2\text{Ge}_5\text{O}_{11}$ (pentagermanic acid) $\text{HGe}_5\text{O}_{11}^-$ (bipentagermanate)	+4 Species/ +6 Species
			+6	$\text{Ge}_5\text{O}_{11}^{2-}$ (pentagermanate)	
		Tin (Sn)	+4	Sn^{+4} (stannic) HSnO_3^- (bistannate) SnO_3^{2-} (stannate) SnO_2 (stannic oxide) $\text{Sn}(\text{OH})_4$ (stannic hydroxide)	+4 Species/ +7 Species
			+7	SnO_4^- (perstannate)	
		Lead (Pb)	+2	Pb^{+2} (plumbous) HPbO_2^- (biplumbite) PbOH^+ PbO_2^{2-} (plumbite) PbO (plumbus oxide)	+2, +2.67, +3 Species/+4 Species
			+2.67	Pb_3O_4 (plumbo-plumbic oxide)	
			+3	Pb_2O_3 (sequioxide)	
		Lead (Pb)	+4	Pb^{+4} (plumbic)	+2, +2.67, +3 Species/+4 Species
				PbO_3^{2-} (metaplumbate)	
				HPbO_3^- (acid metaplumbate)	
				PbO_4^{4-} (orthoplumbate)	
				PbO_2 (dioxide)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
IV	B	Titanium	+4	TiO^{+2} (pertitanyl) HTiO_4^- (titanate) TiO_2 (dioxide)	+4 Species/ +6 Species
			+6	TiO_2^{+2} (pertitanyl) HTiO_4^- (acid pertitanate) TiO_4^{-2} (pertitanate) TiO_3 (peroxide)	
		Zirconium (Zr)	+4	Zr^{+4} (zirconic) ZrO^{+2} (zirconyl) HZrO_3^- (zirconate)	+4 Species/ +5, +6, +7 Species
			+5	Zr_2O_5 (pentoxide)	
			+6	ZrO_3 (peroxide)	
			+7	Zr_2O_7 (heptoxide)	
		Hafnium (Hf)	+4	Hf^{+4} (hafnic) HfO^{+2} (hafnyl)	+4 Species/ +6 Species
			+6	HfO_3 (peroxide)	
V	A	Nitrogen	+5	HNO_3 (nitric acid) NO_3^- (nitrate)	+5 species/ +7 Species
			+7	HNO_4 (pernitric acid)	
		Phosphorus (P)	+5	H_3PO_4 (orthophosphoric acid) H_2PO_4^- (monoorthophosphate) HPO_4^{-2} (diorthophosphate) PO_4^{-3} (triorthophosphate) HPO_3 (metaphosphoric acid) $\text{H}_4\text{P}_2\text{O}_7$ (pyrophosphoric acid) $\text{H}_5\text{P}_3\text{O}_{10}$ (triposphoric acid) $\text{H}_6\text{P}_4\text{O}_{13}$ (tetraphosphoric acid)	+5 Species/ +6, +7 species
V	A	Phosphorus (P)	+6	$\text{H}_4\text{P}_2\text{O}_8$ (perphosphoric acid)	+5 Species/ +6, +7 Species
			+7	H_3PO_5 (monoperphosphoric acid)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
<u>V</u>	<u>A</u>	<u>Arsenic (As)</u>	<u>+5</u>	<u>H₃AsO₄ (ortho-arsenic acid)</u> <u>H₂AsO₄⁻ (mono ortho-arsenate)</u> <u>HAsO₄⁻² (di-ortho-arsenate)</u> <u>AsO₄⁻³ (tri-ortho-arsenate)</u> <u>AsO₂⁺ (arsenyl)</u>	<u>+5 Species/</u> <u>+7 species</u>
			<u>+7</u>	<u>AsO₃⁺ (perarsenyl)</u>	
		<u>Bismuth (Bi)</u>	<u>+3</u>	<u>Bi⁺³ (bismuthous)</u> <u>BiOH⁺² (hydroxybismuthous)</u> <u>BiO⁺ (bismuthyl)</u> <u>BiO₂⁻ (metabismuthite)</u>	<u>+3 Species/</u> <u>+3.5, +4, +5</u> <u>Species</u>
			<u>+3.5</u>	<u>Bi₄O₇ (oxide)</u>	
			<u>+4</u>	<u>Bi₂O₄ (tetroxide)</u>	
			<u>+5</u>	<u>BiO₃⁻ (metabismuthite)</u> <u>Bi₂O₅ (pentoxide)</u>	
	<u>B</u>	<u>Vanadium (V)</u>	<u>+5</u>	<u>VO₂⁺ (vanadic)</u> <u>H₃V₂O₇⁻ (pyrovanadate)</u> <u>H₂VO₄⁻ (orthovanadate)</u> <u>VO₃⁻ (metavanadate)</u> <u>HVO₄⁻² (orthovanadate)</u> <u>VO₄⁻³ (orthovanadate)</u> <u>V₂O₅ (pentoxide)</u> <u>H₄V₂O₇ (pyrovanadic acid)</u> <u>HVO₃ (metavanadic acid)</u> <u>H₄V₆O₁₇ (hexavanadic acid)</u>	<u>+5 Species/</u> <u>+7, +9 Species</u>
			<u>+7</u>	<u>VO₄⁻ (pervanadate)</u>	
			<u>+9</u>	<u>VO₅⁻ (hypervanadate)</u>	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES		
V	B	Niobium (Nb)	+5	<u>NbO₃⁻ (metaniobate)</u> <u>NbO₄⁻³ (orthoniobate)</u> <u>Nb₂O₅ (pentoxide)</u> <u>HNbO₃ (niobid acid)</u>	<u>+5 Species/ +7 species</u>		
			+7	<u>NbO₄⁻ (perniobate)</u> <u>Nb₂O₇ (perniobic oxide)</u> <u>HNbO₄ (perniobic acid)</u>			
			Tantalum (Ta)	+5		<u>TaO₃⁻ (metatantalate)</u> <u>TaO₄⁻³ (orthotantalate)</u> <u>Ta₂O₅ (pentoxide)</u> <u>HTaO₃ (tantalic acid)</u>	<u>+5 species/ +7 species</u>
				+7		<u>TaO₄⁻ (pentantalate)</u> <u>Ta₂O₇ (pertantalate)</u> <u>HTaO₄•H₂O (pertantalic acid)</u>	
		VI	A	Sulfur (S)	+6	<u>H₂SO₄ (sulfuric acid)</u> <u>HSO₄⁻ (bisulfate)</u> <u>SO₄⁻² (sulfate)</u>	<u>+6 Species/ +7, +8 Species</u>
					+7	<u>S₂O₈⁻² (dipersulfate)</u>	
+8	<u>H₂SO₅ (momopersulfuric acid)</u>						
Selenium (Se)	+6	<u>H₂Se₂O₄ (selenic acid)</u> <u>HSeO₄⁻ (biselenate)</u> <u>SeO₄⁻² (selenate)</u>		<u>+6 species/ +7 Species</u>			
	+7	<u>H₂Se₂O₈ (perdiselenic acid)</u>					
	Tellurium (Te)	+6			<u>H₂TeO₄ (telluric acid)</u> <u>HTeO₄⁻ (bitellurate)</u> <u>TeO₄⁻² (tellurate)</u>	<u>+6 species/ +7 species</u>	
+7		<u>H₂Te₂O₈ (perditellenic acid)</u>					
Polonium (Po)		+2		<u>Po⁺² (polonous)</u>	<u>+2, +4 species/ +6 Species</u>		
	+4	<u>PoO₃⁻² (polonate)</u>					
	+6	<u>PoO₃ (peroxide)</u>					

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES		
VI	B	Chromium	+3	<u>Cr⁺³ (chromic)</u> <u>CrOH⁺², Cr(OH)₂⁺ (chromyls)</u> <u>CrO₂⁻, CrO₃⁻³ (chromites)</u> <u>Cr₂O₃ (chromic oxide)</u> <u>Cr(OH)₃ (chromic hydroxide)</u>	<u>+3 Species/</u> <u>+4, +6 Species;</u> <u>+4 Species/</u> <u>+6 Species</u>		
			+4	<u>CrO₂ (dioxide)</u> <u>Cr(OH)₄ (hydroxide)</u>			
			+6	<u>H₂CrO₄ (chromic acid)</u> <u>HCrO₄⁻ (acid chromate)</u> <u>CrO₄⁻² (chromate)</u> <u>Cr₂O₇⁻² (dichromate)</u>			
			Molybdenum (Mo)	+6		<u>HMoO₄⁻ (bimolybhte)</u> <u>MoO₄⁻² (molydbate)</u> <u>MoO₃ (molybdic trioxide)</u> <u>H₂MoO₄ (molybolic acid)</u>	<u>+6 Species/</u> <u>+7 Species</u>
				+7		<u>MoO₄⁻ (permolybdate)</u>	
				Tungsten (W)		+6	
		+8	<u>WO₅⁻² (pertungstic)</u> <u>H₂WO₅ (pertungstic acid)</u>				
		VII	A	Chlorine (Cl)	+1	<u>HClO (hypochlorous acid)</u> <u>ClO⁻ (hypochlorite)</u>	<u>+1 Species/ +3,</u> <u>+5, +7 Species;</u> <u>+3 Species/</u> <u>+5, +7 Species;</u> <u>+5 Species/</u> <u>+7 Species</u>
					+3	<u>HClO₂ (chlorous acid)</u> <u>ClO₂⁻ (chlorite)</u>	
					+5	<u>HClO₃ (chloric acid)</u> <u>ClO₃⁻ (chlorate)</u>	
+7	<u>HClO₄ (perchloric acid)</u> <u>ClO₄⁻, HClO₅⁻², ClO₅⁻³, Cl₂O₉⁻⁴ (perchlorates)</u>						

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VII	A	Bromine (Br)	+1	<u>HBrO (hypobromous acid)</u> <u>BrO⁻ (hypobromite)</u>	<u>+1 Species/+3, +5, +7 Species;</u> <u>+3 Species/ +5, +7 Species;</u> <u>+5 Species/ +7 Species</u>
			+3	<u>HBrO₂ (bromous acid)</u> <u>BrO₂⁻ (bromite)</u>	
			+5	<u>HBrO₃ (bromic acid)</u> <u>BrO₃⁻ (bromate)</u>	
			+7	<u>HBrO₄ (perbromic acid)</u> <u>BrO₄⁻, HBrO₅⁻², BrO₅⁻³, Br₂O₉⁻⁴ (prebromates)</u>	
		Iodine	+1	<u>HIO (hypoiodous acid)</u> <u>IO⁻ (hypoiodite)</u>	<u>+1 Species/+3, +5, +7 Species;</u> <u>+3 Species/ +5, +7 Species;</u> <u>+5 Species/ +7 Species</u>
			+3	<u>HIO₂ (iodous acid)</u> <u>IO₂⁻ (iodite)</u>	
			+5	<u>HIO₃ (iodic acid)</u> <u>IO₃⁻ (iodate)</u>	
			+7	<u>HIO₄ (periodic acid)</u> <u>IO₄⁻, HIO₅⁻², IO₅⁻³, I₂O₉⁻⁴ (periodates)</u>	
	B	Manganese (Mn)	+2	<u>Mn⁺² (manganeous)</u> <u>HMnO₂⁻ (dimanganite)</u>	<u>+2 Species/ +3, +4, +6, +7 Species;</u> <u>+3 Species/ +4, +6, +7 Species;</u> <u>+4 Species/ +6, +7 Species;</u> <u>+6 Species/ +7 Species</u>
			+3	<u>Mn⁺³ (manganic)</u>	
			+4	<u>MnO₂ (dioxide)</u>	
			+6	<u>MnO₄⁻² (manganate)</u>	
			+7	<u>MnO₄⁻ (permanganate)</u>	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VIII	Period 4	Iron (Fe)	+3	Fe^{+3} (ferric) $\text{Fe}(\text{OH})^{+2}$ $\text{Fe}(\text{OH})_2^{+}$ FeO_2^{-2} (ferrite)	+3 Species/+4, +5, +6 Species;
VIII	Period 4	Iron (Fe)	+4	FeO^{+2} (ferryl) FeO_2^{-2} (perferrite)	+4 Species/ +5, +6 Species; +5 Species/ +6 Species
			+5	FeO_2^{+} (perferryl)	
			+6	FeO_4^{-2} (ferrate)	
		Cobalt (Co)	+2	Co^{+2} (cobalous) HCoO_2^{-} (dicobaltite)	+2 Species/ +3, +4 Species; +3 Species/ +4 Species
			+3	Co^{+3} (cobaltic) Co_2O_3 (cobaltic oxide)	
			+4	CoO_2 (peroxide) H_2CoO_3 (cobaltic acid)	
		Nickel (Ni)	+2	Ni^{+2} (nickelous) NiOH^{+} HNiO_2^{-} (dinickelite) NiO_2^{-2} (nickelite)	+2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+3	Ni^{+3} (nickelic) Ni_2O_3 (nickelic oxide)	
			+4	NiO_2 (peroxide)	
			+6	NiO_4^{-2} (nickelate)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VIII	Period 5	<u>Ruthenium (Ru)</u>	<u>+2</u>	<u>Ru⁺²</u>	<u>+2 Species/ +3, +4, +5, +6, +7, +8 Species;</u> <u>+3 Species/ +4, +5, +6, +7, +8 Species;</u> <u>+4 Species/ +5, +6, +7, +8 Species;</u> <u>+5 Species/ +6, +7, +8 Species;</u> <u>+6 Species/ +7, +8 Species;</u> <u>+7 Species/ +8 Species</u>
			<u>+3</u>	<u>Ru⁺³</u> <u>Ru₂O₃ (sesquioxide)</u> <u>Ru(OH)₃ (hydroxide)</u>	
			<u>+4</u>	<u>Ru⁺⁴ (ruthenic)</u> <u>RuO₂ (ruthenic dioxide)</u> <u>Ru(OH)₄ (ruthenic hydroxide)</u>	
			<u>+5</u>	<u>Ru₂O₅ (pentoxide)</u>	
			<u>+6</u>	<u>RuO₄⁻² (ruthenate)</u> <u>RuO₂⁺² (ruthenyl)</u> <u>RuO₃ (trioxide)</u>	
			<u>+7</u>	<u>RuO₄⁻ (perruthenate)</u>	
			<u>+8</u>	<u>H₂RuO₄ (hyperuthenic acid)</u> <u>HRuO₅⁻ (diperruthenate)</u> <u>RuO₄ (ruthenium tetroxide)</u>	
		<u>Rhodium (Rh)</u>	<u>+1</u>	<u>Rh⁺ (hyporhodos)</u>	<u>+1 Species/+2, +3, +4, +6 Species;</u> <u>+2 Species/ +3, +4, +6 Species;</u> <u>+3 Species/ +4, +6 Species;</u> <u>+4 Species/ +6 Species</u>
			<u>+2</u>	<u>Rh⁺² (rhodous)</u>	
			<u>+3</u>	<u>Rh⁺³ (rhodic)</u> <u>Rh₂O₃ (sesquioxide)</u>	
			<u>+4</u>	<u>RhO₂ (rhodic oxide)</u> <u>Rh(OH)₄ (hydroxide)</u>	
			<u>+6</u>	<u>RhO₄⁻² (rhodate)</u> <u>RhO₃ (trioxide)</u>	
		<u>Palladium</u>	<u>+2</u>	<u>Pd⁺² (palladous)</u> <u>PdO₂⁻² (palladite)</u>	<u>+2 Species/ +3, +4, +6 Species;</u> <u>+3 Species/ +4, +6 Species;</u> <u>+4 Species/ +6 Species</u>
			<u>+3</u>	<u>Pd₂O₃ (sesquioxide)</u>	
			<u>+4</u>	<u>Pd O₃⁻² (palladate)</u> <u>PdO₂ (dioxide)</u> <u>Pd(OH)₄ (hydroxide)</u>	
			<u>+6</u>	<u>PdO₃ (peroxide)</u>	

<u>GROUP</u>	<u>SUB GROUP</u>	<u>ELEMENT</u>	<u>VALENCE</u>	<u>SPECIES</u>	<u>SPECIFIC REDOX COUPLES</u>
<u>VIII</u>	<u>Period 6</u>	<u>Iridium (Ir)</u>	<u>+3</u>	<u>Ir⁺³ (iridic)</u> <u>Ir₂O₃ (iridium sesquioxide)</u> <u>Ir (OH)₃ (iridium hydroxide)</u>	<u>+3 Species/</u> <u>+4, +6 Species;</u> <u>+4 Species/</u> <u>+6 Species</u>
			<u>+4</u>	<u>IrO₂ (iridic oxide)</u> <u>Ir (OH)₄ (iridic hydroxide)</u>	
			<u>+6</u>	<u>IrO₄⁻² (iridate)</u> <u>IrO₃ (iridium peroxide)</u>	
		<u>Platinum (Pt)</u>	<u>+2</u>	<u>Pt⁺² (platinous)</u>	<u>+2, +3 Species/</u> <u>+4, +6 Species;</u> <u>+4 Species/</u> <u>+6 Species</u>
			<u>+3</u>	<u>Pt₂O₃ (sesquioxide)</u>	
			<u>+4</u>	<u>PtO₃⁻² (palatinate)</u> <u>PtO⁺² (platynyl)</u> <u>Pt(OH)⁺³</u> <u>PtO₂ (platinic oxide)</u>	
			<u>+6</u>	<u>PtO₄⁻² (Perplatinate)</u> <u>PtO₃ (perplatonic oxide)</u>	
<u>IIIB</u>	<u>Rare earths</u>	<u>Cerium (Ce)</u>	<u>+3</u>	<u>Ce⁺³ (cerous)</u> <u>Ce₂O₃ (cerous oxide)</u> <u>Ce(OH)₃ (cerous hydroxide)</u>	<u>+3 Species/</u> <u>+4, +6 Species;</u> <u>+4 Species/</u> <u>+6 Species</u>
			<u>+4</u>	<u>Ce⁺⁴, Ce(OH)⁺³, Ce(OH)₂⁺², Ce(OH)₃⁺ (ceric)</u> <u>CeO₂ (ceric oxide)</u>	
			<u>+6</u>	<u>CeO₃ (peroxide)</u>	
		<u>Praseodymiu m (Pr)</u>	<u>+3</u>	<u>Pr⁺³ (praseodymous)</u> <u>Pr₂O₃ (sesquioxide)</u> <u>Pr(OH)₃ (hydroxide)</u>	<u>+3 species/ +4 species</u>
			<u>+4</u>	<u>Pr⁺⁴ (praseodymic)</u> <u>PrO₂ (dioxide)</u>	
		<u>Neodymium</u>	<u>+3</u>	<u>Nd⁺³</u> <u>Nd₂O₃ (sesquioxide)</u>	<u>+3 Species/ +4 Species</u>
			<u>+4</u>	<u>NdO₂ (peroxide)</u>	
		<u>Terbium (Tb)</u>	<u>+3</u>	<u>Tb⁺³</u> <u>Tb₂O₃ (sesquioxide)</u>	<u>+3 Species/ +4 Species</u>
			<u>+4</u>	<u>TbO₂ (peroxide)</u>	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
IIIB	Actinides	Thorium (Th)	+4	Th ⁺⁴ (thoric) ThO ⁺² (thoryl) HThO ₃ ⁻ (thorate)	<u>+4 Species/ +6 Species</u>
			+6	ThO ₃ (acid peroxide)	
		Uranium (U)	+6	UO ₂ ⁺² (uranyl) UO ₃ (uranic oxide)	<u>+6 Species/ +8 Species</u>
			+8	HUO ₅ ⁻ , UO ₅ ⁻² (peruranates) UO ₄ (peroxide)	
		Neptunium (Np)	+5	NpO ₂ ⁺ (hyponeptunyl) Np ₂ O ₅ (pentoxide)	<u>+5 Species/ +6, +8 Species; +6 Species/ +8 Species</u>
			+6	NpO ₂ ⁺² (neptunyl) NpO ₃ (trioxide)	
			+8	NpO ₄ (peroxide)	
		Plutonium (Pu)	+3	Pu ⁺³ (hypoplutinous)	<u>+3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species</u>
			+4	Pu ⁺⁴ (plutinous) PuO ₂ (dioxide)	
			+5	PuO ₂ ⁺ (hypoplutonyl) Pu ₂ O ₅ (pentoxide)	
			+6	PuO ₂ ⁺² (plutonyl) PuO ₃ (peroxide)	
		Americium (Am)	+3	Am ⁺³ (hypoamericious)	<u>+3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species</u>
			+4	Am ⁺⁴ (americous) AmO ₂ (dioxide) Am(OH) ₄ (hydroxide)	
			+5	AmO ₂ ⁺ (hypoamericyl) Am ₂ O ₅ (pentoxide)	
			+6	AmO ₂ ⁺² (americyl) AmO ₃ (peroxide)	

Table II: Elements Participating as Heteroatoms in Heteropolyanion Complex Anion Redox Couple Mediators

<u>GROUP</u>	<u>SUB GROUP</u>	<u>ELEMENT</u>
<u>I</u>	<u>A</u>	<u>Lithium (Li), Sodium (Na), Potassium (K), and Cesium (Cs)</u>
	<u>B</u>	<u>Copper (Cu), Silver (Ag), and Gold (Au)</u>
<u>II</u>	<u>A</u>	<u>Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), and Barium (Ba)</u>
	<u>B</u>	<u>Zinc (Zn), Cadmium (Cd), and Mercury (Hg)</u>
<u>III</u>	<u>A</u>	<u>Boron (B), and Aluminum (Al)</u>
	<u>B</u>	<u>Scandium (Sc), and Yttrium (Y) – (See Rare Earths)</u>
<u>IV</u>	<u>A</u>	<u>Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb)</u>
	<u>B</u>	<u>Titanium (Ti), Zirconium (Zr), and Hafnium (Hf)</u>
<u>V</u>	<u>A</u>	<u>Nitrogen (N), Phosphorous (P), Arsenic (As), Antimony (Sb), and Bismuth (Bi)</u>
	<u>B</u>	<u>Vanadium (V), Niobium (Nb), and Tantalum (Ta)</u>
<u>VI</u>	<u>A</u>	<u>Sulfur (S), Selenium (Se), and Tellurium (Te)</u>
	<u>B</u>	<u>Chromium (Cr), Molybdenum (Mo), and Tungsten (W)</u>
<u>VII</u>	<u>A</u>	<u>Fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I)</u>
	<u>B</u>	<u>Manganese (Mn), Technetium (Tc), and Rhenium (Re)</u>
<u>VIII</u>	<u>Period 4</u>	<u>Iron (Fe), Cobalt (Co), and Nickel (Ni)</u>
	<u>Period 5</u>	<u>Ruthenium (Ru), Rhodium (Rh), and Palladium (Pd)</u>
	<u>Period 6</u>	<u>Osmium (Os), Iridium (Ir), and Platinum (Pt)</u>
<u>IIIB</u>	<u>Rare Earths</u>	<u>All</u>

52. (Currently Amended) The apparatus of claim 51, further comprising an anolyte reaction chamber and buffer tank housing the bulk of the anolyte solution, an input pump to enter liquid waste and/or inorganic materials into the anolyte reaction chamber, a foraminous basket disposed in the anolyte chamber for receiving the solid waste and/or inorganic materials, a spray head and stream head to introduce the anolyte from the electrochemical cell into the anolyte reaction chamber in such a manner as to promote mixing of the incoming anolyte and the anolyte mixture in the anolyte reaction chamber, a hinged lid to allow insertion of waste and/or inorganic materials into the anolyte portion as liquid, solid or combination of both, a locking latch to secure the lid during operation of the system, a suction pump attached to the buffer tank to pump anolyte from the buffer tank to the anolyte reaction chamber, an input pump to pump anolyte from the anolyte reaction chamber back to the buffer tank, and an air pump to pump off gases from the anolyte reaction chamber back to the buffer tank for further oxidation.

53 – 65 (Canceled) Without prejudice.

66. (Original) The apparatus of claim 51, wherein the power supply energizes the electrochemical cell at a potential level sufficient to form the oxidized form of the redox couple having the highest oxidation potential in the anolyte, and further comprising a heat exchanger connected to the anolyte chamber for controlling temperature between 0°C and slightly below the boiling temperature of the anolyte with the heat exchanger before the anolyte enters the electrochemical cell enhancing the generation of oxidized forms of the anion redox couple mediator, and adjusting the temperature of the anolyte to the range between 0°C and slightly below the boiling temperature when entering the anolyte reaction chamber.

67 – 71 (Canceled) Without prejudice.

72. (Original) The apparatus of claim 51, wherein oxidation potentials of redox reactions producing hydrogen ions are inversely related to pH, the waste and/or inorganic materials is liquid, solid, and gas or a combination of liquids, solids, and gas and the oxidizing species are interchangeable without changing other elements of the apparatus.

73. (Canceled) Without prejudice.

74. (Original) The apparatus of claim 51, further comprising an ultrasonic source connected to the anolyte for augmenting secondary oxidation processes by heating hydrogen peroxide containing electrolyte to 4800°C, at 1000 atmospheres for dissociating hydrogen peroxide into hydroxyl free radicals and thus increasing concentration of oxidizing species and rate of waste destruction and for irradiating cell membranes in biological materials in the waste and/or inorganic materials to momentarily raise the temperature within the cell membranes to above several thousand degrees, causing failure of the cell membranes failure, and creating greater exposure of cell contents to oxidizing species in the anolyte.

75. (Canceled) Without prejudice.

76. (Original) The apparatus of claim 51, further comprising an anolyte reaction chamber holding most of the anolyte portion and a foraminous basket, a penetrator attached to the basket to puncture solids increasing the exposed area, and further comprising an external CO₂ vent connected to the reaction chamber for releasing CO₂ into the atmosphere, a hinged lid attached to the reaction chamber allowing insertion of waste into the anolyte portion as liquid, solid, or mixtures of liquids and solids, an anolyte pump connected to the reaction chamber, an inorganic compounds removal and treatment system connected to the anolyte pump for removing chlorides, and other precipitate forming anions present in the biological and organic waste being processed, thereby precluding formation of unstable oxycompounds.

77. (Currently Amended) The apparatus of ~~claim 76~~ claim 51, further comprising an off-gas cleaning system, comprising scrubber/absorption columns connected to the vent, a condenser connected to the anolyte reaction chamber, whereby non-condensable incomplete oxidation products, low molecular weight organics and carbon monoxide are reduced to acceptable levels for atmospheric release by the gas cleaning system, and wherein the anolyte off-gas is contacted in the gas cleaning system wherein the noncondensibles from the condenser are introduced into the lower portion of the gas cleaning system through a flow distribution system and a small side stream of freshly oxidized anolyte direct from the electrochemical cell is introduced into the upper portion of the column, resulting in a gas phase continuously reacting with the oxidizing mediator species as it rises up the column past the down flowing anolyte, and external drain, for draining to an organic compound removal system and the inorganic compounds removal and treatment system, and for draining the anolyte system, wherein the organic compounds recovery system is used to recover waste and/or inorganic materials that are benign and do not need further treatment, and waste and/or inorganic materials that will be used in the form they have been reduced.

78. (Currently Amended) The apparatus of claim 76, further comprising thermal control units connected to heat or cool the anolyte to a selected temperature range when anolyte is circulated into the reaction chamber through the electrochemical cell by pump on the anode chamber side of the membrane, a flush for flushing the anolyte, an in-line filter preventing solid particles large enough to clog electrochemical cell flow paths from exiting the reaction chamber, an inorganic compound removal and treatment system and drain outlets connected to the anolyte reaction chamber, whereby residue is pacified in the form of a salt and periodically removed, and

a filter is located at the base of the reaction chamber to limit the size of exiting solid particles to approximately 1mm in diameter.

79. (Canceled) Without prejudice.

80. (Original) The apparatus of claim 51, further comprising an electrolyte containment boundary composed of materials resistant to the oxidizing electrolyte selected from a group consisting of stainless steel, PTFE, PTFE lined tubing, glass and ceramics, and combinations thereof.

81. (Original) The apparatus of claim 51, further comprising an anolyte recovery system connected to a catholyte pump, a catholyte reservoir connected to the cathode portion of the electrochemical cell, a thermal control unit connected to the catholyte reservoir for varying the temperature of the catholyte portion, a bulk of the catholyte portion being resident in a catholyte reservoir, wherein the catholyte portion of the electrolyte flows into a catholyte reservoir, and further comprising an air sparge connected to the catholyte reservoir for introducing air into the catholyte reservoir.

82. (Currently Amended) The apparatus of claim 81, further comprising an anolyte recovery system wherein some anions in the anolyte cross the membrane and are removed through the anolyte recovery system to maintain process efficiency or cell operability for capturing the anions and for reintroducing the recovered mediator anions into the anolyte chamber upon collection from the catholyte electrolyte, an off-gas cleaning system connected to the catholyte reservoir for cleaning gases before release into the atmosphere, and an atmospheric vent connected to the off-gas cleaning system for releasing gases into the atmosphere, wherein cleaned gas from the off-gas cleaning system is combined with unreacted components of the air introduced into the system and discharged through the atmospheric vent.

83. (Original) The apparatus of claim 81, further comprising a screwed top on the catholyte reservoir to facilitate flushing out the catholyte reservoir, a mixer connected to the catholyte reservoir for stirring the catholyte, a catholyte pump connected to the catholyte reservoir for circulating catholyte back to the electrochemical cell, a drain for draining catholyte, a flush for flushing the catholyte system, and an air sparge connected to the housing for introducing air into the catholyte reservoir, wherein the catholyte portion of the electrolyte is circulated by pump through the electrochemical cell on the cathode side of the membrane, and wherein contact of oxidizing gas with the catholyte portion of the electrolyte is enhanced by promoting gas/liquid contact by mechanical and/or ultrasonic mixing.

84. (Canceled) Without prejudice.

85. (Currently Amended) The apparatus of claim 51, further comprising a controller, a microprocessor, a monitor and a keyboard connected to the cell for inputting commands to the controller through the keyboard responding to the information displayed on the monitor, a controller with a control keyboard for input of commands and data, a monitor screen to display operations and functions of the systems, status lights for displaying information about status of the treatment of the mixed waste material, a program in the controller sequencing the steps for operation of the apparatus, program having pre-programmed sequences of operations the operator follows or chooses other sequences of operations, the controller allows the operator to select sequences within limits that assure a safe and reliable operation, the controller sends digital commands that regulate electrical power to pumps, mixers, thermal controls, ultraviolet sources, ultrasonic sources, CO₂ vents, air sparge, and the electrochemical cell, the controller receives component response and status from the components, the controller sends digital commands to the sensors to access sensor information through sensor responses, sensors in the

apparatus provide digital information on the state of components, sensors measure flow rate, temperature, pH, CO₂ venting, degree of oxidation, and air sparging, the controller receives status information on electrical potential across the electrochemical cell or individual cells in a multi-cell configuration and between reference electrodes internal to the anolyte and catholyte chambers of the electrochemical cells and the current flowing between the electrodes within each cell.

86 – 87 (Canceled) Without prejudice.

88. (Currently Amended) The apparatus of claim 51, further A waste and/or inorganic materials oxidizing process comprising a waste and inorganic materials oxidizing process with an operator engaging an 'ON' button on a control keyboard, a system controller which contains further comprises a microprocessor, running a program and controlling a sequence of operations, a monitor screen displaying process steps in proper sequence, status lights on the a panel providing status of the process, opening a lid and placing the waste and/or inorganic materials in a basket as a liquid, solid, or a mixture of liquids and solids, retaining a solid portion of the waste and/or inorganic materials and flowing a liquid portion through the basket and into an anolyte reaction chamber, activating a locking latch after the waste and/or inorganic materials is placed in the basket, activating pumps which begins and circulating the anolyte and a catholyte, once the circulating is established throughout the system, operating mixers, once flow is established, turning on thermal control units, and initiating anodic oxidizing on and electrolyte heating programs, energizing an electrochemical cell to electric potential and current density determined by the program of the controller program, using programmed electrical power and electrolyte temperature ramps for maintaining a predetermined waste and/or inorganic materials destruction rate profile as a relatively constant reaction rate as more reactive waste components are oxidized,

thus resulting in the remaining waste becoming less and less reactive, thereby requiring more and providing more vigorous oxidizing conditions, by activating ultrasonic and ultraviolet systems in the anolyte reaction chamber and catholyte reservoir, releasing CO₂ from the biological and organic materials in the waste and/or inorganic materials oxidizing process in the anolyte reaction chamber, activating air sparge and atmospheric vent in a catholyte system, monitoring progress of the process in the controller by cell voltages and currents, monitoring CO₂, CO, and O₂ gas composition for CO₂, CO and oxygen content, decomposing the waste and/or inorganic materials into water and CO₂, the latter being discharged out of the CO₂ vent, air sparging drawing air into a catholyte reservoir, and discharging excess air out of an atmospheric vent, determining with an oxidation sensor that desired degree of waste and/or inorganic materials destruction has been obtained, setting the system to standby, and executing system shutdown using the controller keyboard system operator.

89. (Currently Amended) The apparatus process of ~~claim 88~~ claim 51, further comprising placing the system in a standby mode during the day and adding waste and/or inorganic materials as it is generated throughout the day, placing the system in full activation during non-business hours, operating the system at low temperature and ambient atmospheric pressure and not generating toxic compounds during the oxidation of the waste and/or inorganic materials, making the process indoors compatible, scaling the system between units small enough for use by a single practitioner and units large enough to for replacing hospital incinerators, releasing CO₂ oxidation product from the anolyte system out through the CO₂ vent, and venting off-gas products from the catholyte reservoir through the atmospheric vent.

90. (Canceled) Without prejudice.